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FACTORY ORGANIZATION AND ADMINISTRATION

BY

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PREFACE TO SECOND EDITION

In rewriting this volume, the material has been rearranged in what appeared to be more logical sequence, and such new matter has been added as the more important developments in the science of management have demanded. The paragraphs have been numbered and given topical headings. References have been added at the close of each chapter to specific portions of modern books bearing on the subject matter of the chapter. These changes are made with a view to making the book more useful as a help to those who wish to make further studies of the topics treated and to facilitate the use of the book as a text.

Hugo Diemer.

State College, Pa.,
December 15, 1913.

PREFACE TO FIRST EDITION

This book is intended to be of service to officers of manufacturing corporations, works managers, superintendents, accountants, and the heads of such departments as purchasing, stores, cost, and production, and in fact to all employees of manufacturing corporations who desire to acquire a comprehensive grasp of the problems treated. It is the result of some twenty years' experience on the part of the writer, of which time about one-half was spent as an employee and about one-half as a consultant.

The work has gradually acquired its present form as the result of lecture courses delivered for a number of years to senior students in engineering colleges, and it is believed that while primarily intended for the actual practitioner in manufacturing work, it will be of value to engineering students.

HUGO DIEMER.

STATE COLLEGE, PA.,
July 1, 1910.

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FACTORY ORGANIZATION AND ADMINISTRATION

CHAPTER I

THE PRINCIPLES, FIELD AND METHODS OF INDUSTRIAL MANAGEMENT

1. Influence of Tradition, Precedent, and Analogy on Industrial Organization.—If we were to look for the influences which have helped to establish the principles of industrial management, we would have to go back earlier even than the beginnings of civilization. When two barbarian tribes made war on each other that tribe which possessed the best fighting organization won out.

Principles of military management were appreciated in the remotest antiquity. Training in discipline and knowledge of different methods of attack, utilizing men best fitted to handle certain kinds of weapons, and disposing of these various classes of men in the most effective ways, how many should be in each group, who should be the leaders in each group, how these leaders should act in concert under the direction of general leaders, were problems of management which were considered and solved 6000 years ago in Egypt, Assyria, and Persia.

Similar problems in organization and management presented themselves in connection with the disposition of the captured prisoners who were usually sold into slavery.

As trade by caravan and vessels developed, new kinds of problems in organization and management developed.

Again as various tribes allied themselves under common leadership they developed governmental and legal organization and administration.

We find at a later date the organization and management of slaves in conducting productive industries, such as brick making, stone hewing, lumber cutting, weaving, and transportation. Still later there came about the development of the so-called guilds and free castes of skilled workmen.

Elaborate and complicated organizations are to be found in the management of the superstitious rites and religions of the various tribes and nations.

We may summarize the sources of tradition, precedent, and analogy from which modern industrial management has been supplied with formative influences as arising from:

(1) Military tradition and usage.
(2) Slavery and serfdom.
(3) Customs of trade and navigation.
(4) Civic and legal customs.
(5) Ancient industrial organizations.
(6) Religious organizations.

2. Data Relating to Industrial Management. Where Found.—The data of industrial management are enumerated in alliterative form by Charles B. Going in a series of words beginning with the letter M, which he designates as "Materials, Markets, Money, Men, and Machinery."

While this list of words is suggestive it will be a little more comprehensive to enumerate the various sciences from which industrial management draws its data and to which it is closely related.

Selecting first from the list given by Mr. Going the subjects of markets and money it is quite apparent that a study of these two topics leads us to an investigation of the science of economics with the view of selecting from that science such data and rules as apply to industrial management. An investigation of the science of economics will lead us to such topics as finance, accounts, and statistics.

We will not have gone far in our study of economics before we find we are bound to get into the fields of social and political science as containing some data relating to industrial management.

Looking again at the list of words beginning with M we find Men. The selection of the right men to do certain work and a selection of the best work for certain men leads us into the field of psychology. We do not need to go far into this field until we begin to realize that the simplest forms of tribal and family life demanded of the leader some instinctive knowledge of the feelings, impulses, and desires of others. He must respect prejudice, be able to persuade to action, secure confidence and obedience. All of these powers imply some knowledge of his own conscience. It is singular that psychology as a vital factor in works management has not been recognized until within the very last few years.

The topics of materials and machinery come under the heading of technical engineering. Engineering knowledge is required also for the proper solution of problems connected with the design and layout of factory plants and buildings, their service equipment including power plants, transmission apparatus, light, heat, ventilation and sanitation, elevators, cranes, mechanical transportation, and the various machines required in the processes of the industries.

We might then summarize as the sciences closely related to the science of management:

(1) Economic, social and political science.
(2) Psychology.
(3) Engineering.

3. Is there a Science of Management?—The simplest definition of science is knowledge methodically digested and arranged. Every science has a subject matter and methods more or less peculiarly its own. Botany, physics and chemistry each have more or less distinct fields and more or less diverse methods. The science of management has its own fields. It describes, analyses, classifies and explains the factors which contribute to bring about efficient industrial conditions and results. It also has methods peculiarly its own.

4. The Field of Industrial Management.—Industrial management is one of the most important economic factors of our time. It is intimately related to problems of individual and national welfare. Hence any improvements that tend to lessen waste and promote health, wealth and happiness in any of the fields of action or departments controlled by the industrial manager are full of a human interest and appeal over and above any technical merit.

Efficiency in industrial management involves efficiency in each of the various divisions with which any management has to deal. A general list of the fields of action covered by industrial management in which there is opportunity for developing efficiency, would include the following: (1) Finance, (2) Organization, (3) Accounting, (4) Industrial plants, their service and process equipment, (5) The selection and handling of employees, (6) Production Systems and Methods, (7) Distribution, including selling and advertising.

5. Efficiency in Finance.—Many concerns are over-burdened by reason of the financing not having been accomplished with the best judgment and ability. More money than necessary may have been spent in promoting. Again, if properties, patents or good will have been paid for by shares of stock, the amount of stock given in payment may have been excessive. In either of these cases the establishment is loaded with a burden of which it cannot rid itself. On account of this well-known fact it frequently happens that a man who is primarily a financier is put at the head of an industrial establishment; and we are then afterward confronted by the condition that although our financing was efficiently done, we have a man at the head of the business who is primarily a financier and knows nothing about manufacturing. He is carried on the pay-roll at a heavy salary, which becomes a constant drain on the establishment. In the case of a bank or brokerage house, this type of man is valuable every day. On the other hand, from the standpoint of the best interests of the manufacturing concern, he is valuable only in cases of financial crisis and is frequently unable to present the true state of internal affairs of the factory to the ultimate ownership.

6. Efficiency in Organization.—There is a wide field open to investigation as to the kinds of departmentalization which have proven most effective in various industries. Another question is that which deals with the extent to which departmentalization shall be carried in various sizes of the same industry—for example, the determination of what is the best form of departmentalized organization for a steam-engine manufacturing company employing 150 men as compared with the departmentalized organization for similar companies employing say 300, 600, 900, or 1200 men.

Efficiency in organization demands definite knowledge of methods of securing individual effort and enthusiasm as well as departmental co-ordination. It demands a knowledge of what has been accomplished by department meetings, by meetings of line officers with separate staff heads, by club, athletic and welfare work among employees, and other means of securing good will and loyalty.

It demands definite knowledge as to how far matters of policy and general procedure may be made the subjects of thought and discussion by men in the ranks and the lower officials as well as by higher officials; and on the other hand, to what extent methods as well as results shall be considered and initiated by the higher authorities.

7. Efficiency in Accounting.—At the head of the accounting department we must have a man who knows how to prepare a balance sheet that will stand the criticism of the most conservative auditor on the one hand; although on the other hand he must be so conversant with current practice as not to fail to list as assets everything to which his company is justly entitled. He must know what constitutes under-valuation as well as what constitutes over-valuation.

He must see the advantage of co-ordinating the manufacturing records with the accounting system. He must realize the great advantage accruing from carrying in terms of money such records as the current accounts of stores, of raw materials, of work in process, and finished stock, and closing these into a monthly balance sheet. He must appreciate the advantage of differentiating the expense accounts so as to allocate them to different kinds of product in a manner that will represent the true costs and true profits of different kinds of product so as to enable the concern making a varied product to compete on the basis of actual knowledge of true costs with a concern specializing in only one of the varied products which his company makes. Here again the old-fashioned bookkeeper type of accountant who urges for a single expense rate based on the old-time percentage plan, because in his opinion it costs less to get this than a differentiated hourly expense rate for the different kinds of product, is wholly out of place and distinctly harmful to the interests of the ultimate ownership in an industrial establishment.

An efficient head of an accounting department needs to have a broader view of his sphere of action than is possessed by a bookkeeper. He must be broad minded enough to avoid blocking the path of progress of the progressive works manager by clinging to old-time methods. The particular old-time methods which he needs to revise are those which have to do with manufacturing and expense accounts. These he needs to rehabilitate so as to show every month or every four weeks classified profits and losses on products and classified expenses per unit of product and per unit of time.

8. Efficiency in Industrial Plants may be said to include efficiency in plant, in equipment, in the departmental arrangement, in power generation and distribution, heating, ventilation, illumination, sanitation, and mechanical transportation of material, and in machine and tool processes.

Efficiency in factory location demands a knowledge of economic and trade conditions acquired only by a very careful study. Efficiency in buildings and the arrangement of departments in these buildings requires a careful study of process mapping and of the types fitted to different classes of industry. Efficiency in equipment required a technical knowledge of all of the processes involved. The problem for one industry is always a problem by itself, yet industries can be classified and types of plant can be selected which are best adapted to certain types of industry.

9. Efficiency in the Selection and Handling of Employees.—The problems of selecting the right man for a given task and selecting the right kind of work for a certain man involve a careful analysis of both the work and the men. This requires a knowledge of the industrial processes whether they be mechanical or mental and also a knowledge of the physical and psychological qualities of various types of individuals.

10. Efficiency in Production Systems and Methods.—The word "production" indicates the making or manufacturing of commodities. Engineering as applied to production means the planning in advance of production so as to secure certain results. A man may be a good mechanic but no engineer. The distinction between the mechanic and the engineer is that the mechanic cuts and tries, and works by formulæ based on empiricism. The engineer calculates and plans with absolute certainty of the accomplishment of the final results in accordance with his plans, which are based ultimately on fundamental truths of natural science.

Instinct and experience are valuable guides to the work of either the mechanic or the engineer, but they serve only as the coast-line does to the mariner without chart or compass. Guided by the chart and compass of his certain knowledge, the engineer is as positive of results in designing, for instance, a machine he has never before seen as is the mariner of reaching a port he may never before have set eyes on.

The mechanical engineer has to do with the design, construction, testing, and operating of machines. The mechanical engineer designs with certainty of correct operation and adequate strength.

It is the business of the production engineer to know every single item that constitutes his finished product, and every step involved in the handling of every piece. He must know what is the most advantageous manufacturing quantity of every single item so as to secure uniformity of flow as well as economy of manufacture. He must know how long each step ought to take under the best attainable working conditions. He must be able to tell at any time the exact condition as regards quantity and state of finishedness of every part involved in his manufacturing process.

Efficiency in production systems and methods demands a thorough understanding of the matters connected with the phases of manufacturing which are included in what is at the present time designated as the planning department. This involves a knowledge of the correct handling of such matters as bills of material, drawing lists, perpetual inventories of stores, purchase records, process maps, route diagrams and charts, instruction cards, time and motion studies, tool lists, order of work and tracing records, methods of promptly moving work in process from department to department, as well as best methods of carrying on the productive processes of an industry, including such matters as feeds and speeds of machines, belt, chain and motor drives, repairs to machinery, and inspection and test of product.

The engineer must be able not only to design, but to execute. A draftsman may be able to design, but unless he is able to execute his designs to successful operation he cannot be classed as an engineer. The production engineer must be able to execute his work as he has planned it.

11. Efficiency in Distribution and Selling.—There are many correspondence courses in salesmanship offered at the present time. A study of any of these courses will reveal the large field open for work in the interests of greater efficiency. Efficiency in the selling department recognizes the fact that it is not quantity of sales which merits extra pay. That particular salesman or selling office is entitled to the greatest reward who has sold goods on which the manufacturer has made the largest profits, whether it has been the result of quantity of sales or of careful selection, with an effort to sell those things on which the manufacturer could realize the greatest profit.

Progressive efficiency in selling demands extensive research work in various industries to accumulate data covering the methods and actual costs of selling. It is only by the accumulation and comparison of such data that we, as a nation, can make progress in reducing distribution costs.

Finally it must be recognized that economies in production together with lower costs of manufacture will result in continual manufacturing activity only if some corresponding reductions in selling prices are made. National and international economy demands that production of all kinds be maintained at a maximum; and in order that this condition may exist, we must be content with such profits as will provide fair returns in the way of dividends on actual investment, sinking funds to cover depreciations and a reasonable reserve for bad business years. After these obligations have been met, however, there is no justification from an economic standpoint for adding any further profit over cost of production to increase selling price.

12. The Methods of Industrial Management.—A committee of the American Society of Mechanical Engineers made an extensive canvass in the fall of 1912 to determine what were the new elements in modern management as well as what the committee designated as the regulative principles of industrial management. The committee confirmed Adam Smith's statement made in 1776 in his "Wealth of Nations," in which he held that the application of the principle of division of labor was the basis of manufacture. The committee also agreed with Charles Babbage, who in his work entitled "Economy of Machinery and Manufacture" written in 1832, added another principle, namely the transference of skill. The committee quotes from Adam Smith's "Wealth of Nations," as follows:

> "This great increase of the quantity of work which, in consequence of the division of labor, the same number of people are capable of performing, is owing to three different circumstances; first, to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and lastly, to the invention of a great number of machines which facilitate and abridge labor, and enable one man to do the work of many."

They also quote from Charles Babbage's "Economy of Machinery and Manufacture" as follows:

> "That the master manufacturer, by dividing the work to be executed into different processes, each requiring different degrees of skill and force, can purchase exactly that precise quantity of both which is neces-

sary for each process; whereas, if the whole work were executed by one workman, that person must possess sufficient skill to perform the most difficult, and sufficient strength to execute the most laborious of the operations into which the art is divided."

The committe also reported that methods of analyzing and recording operations were early developed. Charles Babbage gives a table from a French investigator showing the number of operations, time for each, cost of each, and expense of tools and materials for making pins in France in 1760.

13. Prominent Principles of Management.—As a result of the above investigations the committee state that they conceive the prominent element in present-day industrial management to be: the mental attitude that consciously applies the transference of skill to all the activities of industry.

The committee report the following as the most satisfactory answers to the question: "What are the regulative principles of industrial management?"

The regulative principles of management along scientific lines include four important elements:

(a) Planning of the processes and operations in detail by a special department organized for this purpose.

(b) Functional organization by which each man superintending the workman is responsible for a single line of effort. This is distinctly opposed to the older type of military organization, where every man in the management is given a combination of executive, legislative and judicial functions.

(c) Training the worker so as to require him to do each job in what has been found to be the best method of operation.

(d) Equable payment of the workers based on quantity and quality of output of each individual. This involves scientific analysis of each operation to determine the proper time that should be required for its accomplishment and also high payment for the worker who obtains the object sought.

Another correspondent finds the solution of problems of management in the observing and regulating of three classes of industrial phenomena:

"(a) The economic results of different arrangements and forms of materials and operations upon them, either to produce equipment or product. This covers the whole field of recorded experience from invention and design of product and tools down through the successive shop processes to ultimate finished product and its tests in service. It is the object of the scientific method to make the best of this experience, in its essential details, readily available for all concerned, and to see that it is actually absorbed and put in practice.

"(b) The economic results of varying executive methods for effectively directing human efforts as a whole in the use of the above experience. This covers the entire field of building up, co-ordinating and controlling the supervising organization of a plant with its statistical and recording systems.

"(c) The economic results of steps taken to raise the industrial efficiency of the individual worker in every grade of service. This covers the whole problem of labor reward, intensified ability, conserved energy and the general relations of employer and employee."

14. Regulative Principles of Management.—Messrs. Church and Alford have attempted to condense the above regulative principles still further and have defined them as: (a) The systematic use of experience; (b) The economic control of effort; (c) The promotion of personal effectiveness.

The first includes the use, in all essential detail, of traditional knowledge, personal experience and the results of scientific study on the part of the executive force. It implies the accumulation and use of records and the setting up of standards.

The second includes the division and subsequent co-ordination of both executive and productive labor; the planning of single lines of effort, the setting of definite tasks and the comparison of results; and the effective training of the workers. It implies the previous acquisition of skill by the executives.

The third includes a definite allotment of responsibility and the adequate, stimulative encouragement and reward of both executive and productive labor; the development of contented workers, and the promotion of their physical and mental health. It implies the most thorough comprehension of the human being.

15. Methods of the Science of Management.—In the first edition of this book the writer outlined the methods of the industrial engineer as follows:

He considers a manufacturing establishment just as one would an intricate machine. He analyzes each process into its ultimate, simple elements, and compares each of these simplest steps or processes with an ideal or perfect condition. He then makes all due allowances for rational and practical conditions and establishes an attainable commercial standard for every step. The next process is that of attaining continuously this standard, involving both quality and quantity, and the interlocking or assembling of all of these prime elements into a well-arranged, well-built, smooth-running machine. It is quite evident that work of this character involves technical knowledge and ability in science and pure engineering, which do not enter into the field of the accountant. Yet the industrial engineer must have the accountant's keen perception of money values. His work will not be good engineering unless he uses good business judgment. He must be able to select those mechanical devices and perfect such organization as will best suit present needs and secure prompt returns in profit. He must have sufficiently good business sense to appreciate the ratio between investment and income. He must be in close enough touch with the financial management to be able to impress upon them the necessity of providing sinking funds to provide for the more perfect installations and organizations which future demands of a more educated and enlightened public will necessitate.

The industrial engineer to-day must be as competent to give good business advice to his corporation as is the skilled corporation attorney. Upon his sound judgment and good advice depend very frequently the making or losing of large fortunes.

16. Taylor's Definition of the Methods of Industrial Management.—Fred W. Taylor summarizes the methods of industrial management as follows:

(1) *The Establishment into Scientific Form of all of the Working Data and Rule of Thumb Knowledge Relating to a Given Industry.*—As an example of the practical application of this method we have Mr. Taylor's own exhaustive treatise on "The Art of Cutting Metals."

(2) *The Scientific Study of the Workers.*—To illustrate what sort of investigation this involves we may again refer to Mr. Taylor's investigations as to the physical and temperamental qualifications of men best adapted to such work as shoveling iron ore, carrying pig iron, etc.

(3) *Bringing the Science to the Worker.*—This is accomplished through the medium of functional foremanship. Each functional foreman is an expert teacher in his speciality.

(4) *The Assumption by the Management Itself of Its Due Share in the Above-mentioned Three Divisions.*

REFERENCES

CHEYNEY: "Industrial and Social History of England," Chapters II–IX.

COMAN: "Industrial History of the United States," Chapters II–IX.

DAY: "History of Commerce," Part IV.

WRIGHT: "Industrial Evolution of the United States," Parts I, II and IV.

GOING: "Principles of Industrial Engineering," Chapters I and II.

Transactions A. S. M. E., 1912. Report of Committee on Present State of Industrial Management: No. 1378, pp. 1131–1229.

Tuck School Conference on Scientific Management: pp. 28–35.

CHAPTER II

INDUSTRIAL FINANCE

17. The Corporation.—The present-day theory of a corporation is that it is an organized body of individuals who have agreed to co-operate in the conduct of some enterprise in accordance with federal and state laws as well as certain by-laws made by themselves. This theory is quite different from that of the previous generation which held that a corporation was an intangible, invisible, entity, with perpetual existence, otherwise having all the attributes of a natural person. The present-day theory of the corporation does not segregate the directors and stockholders from the invisible and frequently well-named soulless mystery the corporation itself. To-day the officers, the directors and the stockholders are themselves the corporation. The acts of the corporation are the acts of the directors and their agents. Inasmuch as the directors are the agents of the stockholders, the stockholders are responsible for the acts of the directors in so far as the directors are acting within the limits of the authorization conferred on them by the stockholders themselves. The fact that the courts are interpreting more and more the corporation as a body of individuals each of whom shares in the responsibility for the acts of the corporation itself should serve as a warning to stockholders, directors, and responsible officials in all corporations to exercise care and forethought in seeing that there can be no charge substantiated that any acts of the corporation violate common law, statutory law or public policy. The commission of such acts, according to present-day intrepretation of the courts, involves not only the intangible, invisible thing known as the corporation but may mean civil and even criminal action against the individuals composing the corporation as well as those individuals in particular responsible for such acts.

18. The Corporation Charter.—Incorporation is secured by the granting of a charter. This charter is usually granted by the office of the secretary of state of the state in which incorporation is sought, after the publication of the application for a stated time in certain newspapers. In its ordinary form the charter is furnished by the office of the secretary of state in brief standard printed form which refers to the act or acts of the legislature and also sometimes to the constitution of the state issuing the charter, as specifying in further detail the terms under which the charter is granted. This standard printed form of charter is, however, not the only form of charter issued. Certain large corporations, in order to secure the widest freedom of action possible, have had their attorneys prepare charters so worded as not to conflict with the laws of the state in which incorporation is sought, but securing a wider range of possible activities than would be expressly stated in the standard form of charter. Applications for special forms of charter thus prepared have usually been granted, although the question has been raised by outsiders whether the wide scope of activities allowed in some cases is in accordance with the interest of public policy.

19. Where to Incorporate.—The natural place for an industrial organization to incorporate would seem to be the state in which its plant is located, or, if it operates plants in several states, the state in which its principal plant is located. There is a certain prestige gained by being known as a home industry rather than a foreign corporation, the word "foreign" being used in the sense of belonging to another state. Incorporation in the home state might involve the acquisition of a certain amount of good will from the people at large of that state. Again there is a tendency in some states to license or tax foreign corporations and exempt home corporations from such licenses or taxes.

Certain states limit the powers of corporations so far as the scope of their business activities is concerned more than other states and this may be a deciding factor in selecting the state in which to incorporate. Again the cost of the charter varies in different states. Certain states which grant special privileges to corporations levy a heavy tax in the form of incorporation fee, while other states, which are more strict with regard to privileges allowed corporations, charge a relatively small fee. The form of capitalization desired may decide the selection of the state in which to incorporate. The conservative and closely held corporation may choose to issue but one kind of capital stock and sell this stock for cash only. Such a corporation can afford to incorporate in the state in which its plant is located no matter how strict may be the corporation laws of that state. On the other hand a corporation may wish to issue stock in exchange for property contributed by subscribers or in exchange for services rendered by promoters. Certain states are more liberal than others with reference to the matter of allowing stock to be issued for such things as property, services, patent rights, bonus, good will, franchise, etc., than other states. Again some states allow corporations to buy and sell stocks of other corporations, while other states prohibit this. The conservative corporation has everything to gain by incorporating under laws of a state which is strict and has nothing to gain by incorporating under the laws of a state having so-called liberal corporation laws. On the other hand there are many successful corporations which have been organized by capable business men who had very little money themselves to start out with and who it is claimed could never have capitalized their businesses if they had been compelled to conform to the corporation laws of some of the stricter states.

20. Governmental Control of Corporations.—So far as their intra-state business is concerned, namely the business entirely within the state in which they are incorporated, corporations are subject to (a) the terms of the charter under which they are operating; (b) the by-laws adopted by the stockholders; (c) the constitution of the state; (d) the statutes of that state; (e) common law; (f) public policy. So far as inter-state acts of corporations are concerned they are subject to (a) the federal constitution, (b) the federal statutes and (c) the interpretation by the federal courts of questions as to whether they are violating common law or public policy. It has been frequently urged that all corporations doing inter-state business should be subject to federal incorporation. Advocates of federal incorporation are hoping that the confidential data accumulated by the federal government in connection with the federal corporation tax as well as the principle of federal control carried with the act, may open the way for the construction of such a federal incorporation act.

21. State Corporation Commissions.—The establishment of corporation commissions in various states to pass on the soundness of the financial plans of corporations seeking to sell their securities and to determine whether these companies shall be allowed to sell their securities in that state or not, is another recent phase of governmental control. These commissions have been designated in popular parlance as "blue sky commissions" for the reason that corporations having very little tangible property to show back of the securities they are offering have been designated as "blue sky companies."

Popular demand to-day is for the establishment of corporation commissions in the states, who shall look after the interests of the investor and consumer as well as the just rights of incorporators and apply a uniform standard to all in questions of appraisal of the value of tangible and intangible assets for which securities are proposed to be issued.

The valuation of corporation assets by a commission would be desirable from the standpoint of the investor and consumer in such cases as the following:

A has a business actually worth $10,000. He agrees with B that B shall put in $10,000 cash and secure a half interest in a company which is to be incorporated with $30,000 paid up stock on the following plan. An appraisal committee is to prepare an inventory showing the value of A's business as $20,000 instead of its real value of $10,000. The corporation will buy from A his business for $20,000 worth of stock. B subscribes for $10,000 worth of stock and pays for it in cash. A secret contract is made by A and B whereby A agrees to transfer to B $5000 worth of stock apparently for cash at par value. B agrees to write out a check in favor of A for $5000, A is to get this check cashed and is to return the cash immediately back to B. The paper records show that B has paid par value in cash for his original $10,000 worth of stock, also that he paid A par value in cash as per bank account and checks which can be shown for his additional $5000 worth of stock. A and B now each own $15,000 worth of stock which has cost each of them only $10,000 and they are in a position to sell stock at a profit to minority stockholders. The figures and conditions of the hypothetical case given can, and usually are adjusted to suit any particular case under existing corporation laws. A strict corporation commission with capable appraisers might prevent A from having his business appraised at more than $10,000 valuation. It is apparent, however, that to secure such results the commission would have to be absolutely non-political and provided with a sufficiently large and capable force of appraisers to do its work thoroughly.

22. Organization Prior to Incorporation.—The real organization of most corporations is planned or "slated" prior to the first subscribers' meeting. The promoters get together and determine what shall be their compensation, who shall be the directors and officers, what shall be the by-laws, how the stock shall be allotted in the case of over-subscription, what course shall be followed in case of under-subscription, and many other details, which are apparently solved by the free action of the subscribers at the first meeting. At the first meeting somebody usually nominates a temporary chairman as previously agreed on. This motion is usually unanimously carried. Then the temporary secretary is nominated and usually unanimously elected. Next a motion is made that the chairman appoint a nominating committee to nominate officers. This motion is also usually carried. It has been advocated that statutes should be passed providing a set of rules governing the conduct of subscribers' meetings. Such statutes would be very desirable, as under existing conditions promoters claim that there is no law which requires even the usually accepted rules of parlimentary procedure to be followed in conducting a subscribers' meeting. For instance if one of the subscribers ventured to move that the nominating committee be elected by ballot or that directors be nominated by petition and elected by ballot the temporary chairman could simply declare such a motion out of order and declare in order only such motions as are made by the promoters in accordance with the agreed program.

23. Capitalization.—The simplest form of capitalization is that in which there is only one kind of stock, the shares of which have been paid for in cash at par value. This simplest form, however, is less usual in the present generation than formerly. The requirements of modern industrial undertakings for large working capital, and expensive plants and equipment have made it necessary for the industrial corporation established in recent years to pattern itself somewhat after the railroad in its methods of capitalization.

24. Bonds.—Industrial bonds are at present confined almost exclusively to first mortgage bonds secured by real estate and plant. It frequently happens that the citizens of a town desirous of securing an industrial plant will donate the ground and subscribe locally for first mortgage bonds of a sufficient amount to put up either the buildings alone or the buildings and equipment. In such cases a contract can be made between the bond-holders and the corporation regulating the amount that is to be set aside per unit of product to meet interest on bonded indebtedness and to provide a sinking fund for paying off the bonds. For instance, in the case of an automobile factory the contract printed on the bond might specify that $20.00 per car is to be set aside for every car sold, to meet the interest and sinking fund requirements on the bond issue.

Equipment bonds and debenture bonds have not as yet been employed to any extent in industrial undertakings. It is possible that the future may see their more extensive use in this field.

25. Preferred Stock.—Preferred stock has priority of claim over the common stock in sharing any profits. Formerly preferred stock was usually non-voting stock. A good deal of preferred stock in recent years however is voting stock. In some cases it becomes voting stock only if the dividend on the preferred stock has not been paid. It is becoming the custom to limit the amount of preferred stock issued by industrial corporations to a figure which fairly represents the value of unburdened tangible assets. For instance if the real estate and buildings were covered by a mortgage securing a bond issue, and if the equipment were not so burdened, then the preferred stock issue might represent the value of the equipment, the raw material on hand, work in process in the shops, and the finished stock on hand. Industrial preferred stocks usually pay a rate of dividend from 1 to 2 per cent. per annum higher than the bonds. In some cases it may not be necessary to issue both bonds and preferred stock. Under such circumstances the bond issue has the advantage of being more easily marketed and paying a lower rate of interest than would have to be paid on a preferred stock. On the other hand preferred stock if it is non-cumulative does not carry with it the same obligation to pay the dividend every year as is involved in the compulsion to pay the interest on the bonds. Most industrial corporations, however, make extreme efforts to pay dividends on their preferred stock as the failure to pay such dividends always results in a sharp decline of the market value of all securities of the corporation. If the preferred stock is cumulative, any dividend which has not been paid in any one year remains as an obligation to be paid out of future profits before any dividend can be paid on the common stock.

26. Common Stock.—Common stock is in most cases the only voting stock. The conservative industrialist sometimes prides himself on the fact that his company has issued but one kind of stock, namely, common stock. It is difficult under present-day methods of finance to dispose of common stock at par for cash, in view of the widespread custom of using common stock as a bonus to be given away to subscribers to bonds or preferred stock of new corporations.

What relation may the amount of common stock bear to other securities issued? The conservative method of issuing common stock is to retain as unissued stock a sufficient quantity of authorized common stock so that the total outstanding securities of all kinds will not exceed the total volume of business done in a year representing an average condition of trade. Under such circumstances the profits on a year's business should be ample to pay interest and sinking fund requirements on the bond issue, as well as dividends on the preferred and common stock and permit some allotment of undivided profit to a surplus fund. Take for example an industrial corporation doing a business of $1,000,000 worth of sales a year. We might reasonably expect that after all production costs and expenses were met, together with all selling and office expenses outside of officers' salaries, a favorable balance of $100,000 would be left. This $100,000 would have to be utilized to pay interest and sinking fund on bonds, interest on stock, officers' salaries and leave some surplus on hand, approximately as follows:

Interest at 6 per cent. on $100,000 bonds	$6,000
Sinking fund	4,000
Dividend at 7 per cent. on $300,000 preferred stock	21,000
Dividend at 6 per cent. on $600,000 common stock	36,000
Surplus or depreciation fund	3,000
Total exclusive of officers' salaries	70,000
Balance left for officers' salaries	$30,000

The above figures are not very far out of the ordinary for a $1,000,000 concern. One does not have to do much figuring to demonstrate that a concern with $1,000,000 capitalization cannot afford to pay more than about three $10,000-a-year salaries to officers, unless the profits on the business are abnormally high.

It is frequently attempted to controvert such figures as the above by the statement that certain officers who are receiving salaries of from $10,000 to $25,000 per year are actual producers in that they are, as the case may be, exceptionally capable financiers, organizers, managers, designers, or sales managers, and that their salaries should be considered as part of the cost of production. Such arguments are not so easily met where the industry in question is a natural or artificial monopoly. But where there is competition, either domestic or foreign, the cost of the output and salaries paid for equivalent service are determinable. Exorbitant salaries to officers and to favored stockholders have not been recognized until quite recently as one of the greatest obstacles to American trade supremacy and to the proper distribution of the benefits of the science of industrial management.

27. Depreciation.—Depreciation of plant and equipment is a loss incurred every year. Inasmuch as losses and assets are listed on the same side of the balance sheet it is important to discriminate between an item which shows depreciation as a loss and an item which shows a depreciation fund in the form of a bank account, or securities purchased to offset this loss. In order to make the matter clear it is always well to specify after the words "depreciation fund" the form which this fund takes. Writing down the word "depreciation" only, without specifying the nature of the fund might lead a reader to believe that no actual fund existed and that the depreciation was merely a loss.

Depreciation cannot be satisfactorily determined by the use of arbitrary tables. In a given industry each type of plant and equipment has a determinable period of useful active life. At the end of this period the plant or equipment has also some residual value, as scrap or second-hand outfit. To determine the depreciation, subtract the residual value from the initial cost. To distribute this depreciation by annual allotments over the period of useful active life is not so easy as would at first sight appear. One's first thought is that if we divide the total depreciation by the number of years of useful life we would have the annual depreciation. We need to bear in mind, however, that depreciation funds invested in securities are accumulating interest. Hence we need to determine from annuity tables the amount to be set aside each year in order to net us at the end of the period of useful life the total depreciation sum.

The ultra-conservative enterprise with plenty of funds may invest such sums in bank or in securities. The argument against this practice is that the business itself must yield more profits than such investments. Hence the depreciation reserve it is argued is best reinvested into tangible assets of the business, preferably equipment. If this is the form of investment, the question arises as to whether the annual amount of depreciation shall be considered as (a) the quotient of the total depreciation divided by the period of useful life, or an annuity table sum based on (b) ordinary savings bank interest rates, or (c) the average dividend rate of the given business. Evidently (a) is the most conservative and (c) the least conservative practice.

Depreciation must be recognized as something which happens every year and must be met. It is an obligation which cannot be shifted from one year to the next in anticipation of a year of good profits. Auditors and critical investors are paying more and more attention to the manner in which a corporation management provides for distribution as one of the important means of gauging the integrity and stability of the corporation in question.

REFERENCES

Lough: "Corporation Finance," Chapters I–XIV.
Cooper: "Financing an Enterprise," Parts I–IV.
Bentley: "Corporate Finance and Accounting," Chapter I.
Conyngton: "The Modern Corporation," Chapters I–XII.
Sullivan: "American Corporations," Chapters I–VII.
Ennis: "Works Management," Chapter VII.
Humphreys: "Lecture Notes on Business Engineering," Pages 258–318, 53–61, 29–39.
Hatfield: "Modern Accounting," Chapter VII.
Cole: "Accounts," Chapter VIII.

CHAPTER III

ORGANIZATION AND CONTROL

28. Organization.—Organization consists of the laying out of the scope and limits of action of the various individuals and groups of individuals whose work is required for carrying on the objects of the establishment. It consists further of the uniting of these individuals and groups of individuals in such a manner as to co-operate for the common good, harmoniously, promptly, and economically. There is no greater source of economy than conservation of human energy through efficient organization. To obtain the largest possible return from a given expenditure of capital and labor, the industrial organization must be logical, systematic and scientific. A well-designed organization will do much to bring about mutual confidence and co-operation. The confidence of the men must be obtained. They must appreciate that it is to their own interests as well as to the interests of the community and stockholders to deliver the right kind of work. The right kind of organization will do much toward developing the right sort of industrial intelligence among all the working men, a factor of more importance than superlative refinements in the testing department.

29. Organization Something Distinct from Management and System.—Organization is distinct from system and management. An industrial establishment may have excellent filing and accounting systems, but no well-defined lines of organization. Again there may be clearly defined organization, but very poor management. The distinction between organization, management, and system is important, and must be fully appreciated. We organize to manage. We manage largely through system. We manage successfully when we apply not only the principles fundamental to correct organization and system, but when we take into account all the principles and methods of industrial management. Some enthusiasts on industrial and business psychology while recognizing the importance of dealing correctly with the human factor in works management, do not lay enough stress on the other basic principles and methods of industrial management. Management is the whole, of which organization, system, industrial psychology, and other elements and methods are parts.

30. System.—There is a pronounced tendency by consulting experts to lay the greatest emphasis on certain methods of analysis and synthesis and certain peculiar forms of record and equipment. Certain experts have gathered together certain peculiar methods and have added to them certain principles of management, and then dubbed the whole the "Blank System of Management." Proprietors who have seen the benefits gained by certain of these methods and systems in their particular industries are enthusiastic in their praise and advocacy of them. These methods and systems where they have been successful, are as deserving of praise and reward as great mechanical inventions. But it must be borne in mind that if we are endeavoring to formulate basic principles of the science of management, they are merely illustrative factors. To illustrate specifically, Mr. Carl Barth has invented a remarkable slide-rule for determining the best methods of metal removal by machine tools. Mr. Sanford Thompson has invented a high-grade decimal stop-watch. Both of these gentlemen are as much authorized to speak of their methods as the Barth System or the Thompson System, as certain men who have attached their names to methods and systems which they designate as "Systems of Management." Both of the gentlemen in question, however, recognize that while there may be a science of management, it would be as incorrect to speak of a system of management, as it would be to speak of a system of economics, or a system of psychology. Even Dr. Taylor, who has done more than any one individual in establishing the principles and methods of industrial management on a scientific basis, prefers the term "Scientific Management" to the term "The Taylor System." Special methods and systems represent practices based on a foundation of centuries of experience by earnest men in actually doing the world's work.

31. Control.—To lay out a new organization or to analyze an existing organization we must determine first the processes and classes of activity required of plant, equipment and individuals. This demands a knowledge of all the interior workings of an industrial establishment. The process of building up an organization that shall be the best for a certain factory depends primarily upon scientific research work, having for its object the dissection of the entire series of internal workings into the elementary steps. We must list these in detail. Following this analytic process comes the even more difficult synthetic one of preparing a structure which shall be the most efficient possible engine of industrial production of its type. We must determine which of these prime elements are to stand alone, and which are to be combined, so that the general result will make a well-arranged, well-built, smooth-running machine, as it were, of the entire aggregation.

Such determination requires an inspection of the establishment with a view to determining what type of control is applicable to its various branches. Control may be based on the principle of military authority as exemplified by the line officers, on specialization, on functionalization, or on a combination of different degrees of two or more of these principles. Each of these principles will be dwelt on in further detail.

32. Numerical-Military Type.—The numerical type of departmentalization and control, sometimes designated as the military type, divides the men into groups in such a manner that each group receives its orders and instructions of all kinds from one man only. In this type in its extreme form, workmen are definitely instructed that in all matters they are expected to receive and obey orders from their gang boss only, he in return being responsible only to the assistant foreman, the assistant foreman to the foreman, and so on. In its modified type, instructions may be taken from any line officer superior in rank. This modified type is quite possible without conflicting orders.

33. Specialization.—The principle of specialization demands that all similar duties, handicrafts and trades be selected and performed by one man or group of men so far as processes and classes of activity permit. The departmental division then follows processes, trades, handicrafts and classes of labor and equipment. The principle of specialization has come into pretty general application even in conservative establishments. It is exemplified in the manufacturing side by such departments as lathe, automatic screw machine, miller department, etc., and in the commercial side by such departments as correspondence, sales, etc.

Specialization is an economic necessity, but over-specialization is to be avoided. After all it is the all-around men, the versatile, widely informed department heads, who form the vertebræ of the backbone of a successful organization. Among laborers, mechanics and minor bosses, it is safe and proper to go to extreme limits in specializing, but among those who are to fill posts of higher responsibility, we should avoid drawing the lines of specific organization with prescribed limitations of authority so closely as to thwart ambition.

This desideratum can be brought about by grouping allied specialized departments with a general officer as the head of the group. Such general positions afford incentives in the way of promotion to specialists and also provide insurance of succession when an unexpected vacancy occurs. It is impossible to foresee or prepare for the unexpected vacancy or other contingency which will demand experience in exercising independent judgment and all-around knowledge of an industry, qualifications which are stifled by over-specialization and too great limitation of the powers of higher officials.

With the development of the manufacturing side, we begin to have, not only increased departmentalization by handicrafts, trades and types of machinery, but we have as a rule the division of metal machine-shop work into three classes, namely tooling, group assembly, and final assembly or erecting. Next comes the recognition of the advantage of distinct departments of works engineering (including power, light and heat), design of product, tool designing, stores, orders, shipping, cost and other factory accounts, etc. Many organizations have developed specialized departmentalization without the development of the principle of functionalization.

34. Functionalized Type.—This term is used to designate a type of control in which there is delegated to a staff officer or department, absolute control over certain features, performances or functions common to all departments but distinct from specialized duties. To distinguish between specialization and functionalization we may define a specialist as an individual who is expert in a certain trade, handicraft or science which is an essential constituent of the particular industrial process of the given establishment. A functional staff officer or bureau, on the other hand, investigates a single phase or aspect common to all these handicrafts, trades and sciences.

Functional management is more than the assignment of the one function to a specialist, which is the distinguishing feature of specialization. Functionalization determines what functions come into play in managing *all* departments, each functional head for any one function being supreme in that function in all departments.

It is by means of the functional departments and staff officers that the efficient modern organization best accomplishes the co-ordination which is so necessary after departmental specialization has been well instituted. Functional organization and control which does away altogether with line control, is a distinguishing feature of Doctor Taylor's methods. He has three functional heads in what he designates as the planning department, namely, a head for the order-of-work clerks, a head for the instruction-card men and a head for the cost-and-time clerks. In the shop side he has four functional heads, namely, the gang boss, the speed boss, the inspector and the repair boss. An eighth functional head, namely, the shop disciplinarian, acts in the capacity of arbitrator of all differences. The functional men in the planning-department group operate as a whole through the head of the "order-of-work" clerks, who is the medium connecting the planning room with the shop bosses and through them with the mechanics and laborers (see Fig. 1).

To a certain extent industrial establishments more or less unconsciously adopted some of the principles of staff control as developed in the modern military organization. Harrington Emerson divides staff control to cover four groups, namely: Men, materials, equipment, methods and conditions. He advocates line organization for discipline and permanence and the staff for expert guidance.

35. Selecting Organization and Control.—It would be very difficult to set down a standard type to apply to all industrial establishments. However, it is quite possible to present a conventional general type of combined staff and line control adaptable with modifications to most industries. This conventional type is then to be carefully inspected and studied by all persons who are to lead in carrying out the plans for organization prior to adopting any given system. In deciding on what production, cost system, or wage system to use, it should be remembered that men of exceptional ability may devise systems of exceptional merit, but they must either keep personal representatives of high ability permanently in charge of those systems, or else turn them over to average proprietors and employees to handle. And it is the personal inefficiency of the average proprietors and men who operate the systems that determines the practical limitations of their usefulness. No system should be forced onto employees. Their co-operation must be secured first.

In planning a new organization, meetings should be called of the various existing officials and department heads. These meetings should be continued until a form of organization has been agreed upon. The sum total of the knowledge of a number of intelligent men is generally greater than that of any one of them, and action taken by an executive after consultation with the leading members of an organization, even if it is not in exact accord with majority opinion in some instances, is generally conservative and safe. In management, and particularly in developing an organization whose function it is to manage, the personal equation cannot be ignored.

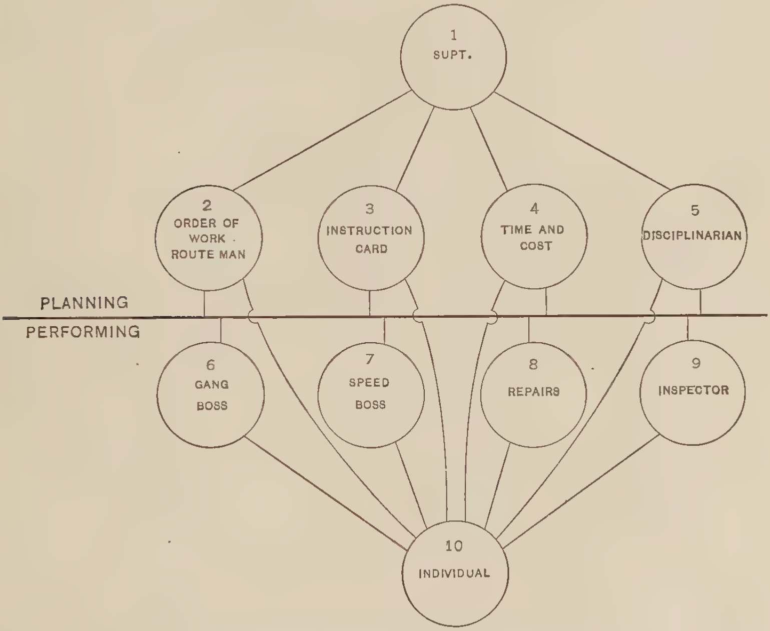


Fig. 1.—Chart prepared by F. B. Gilbreth to illustrate functional control according to F. W. Taylor.

It is more important to know who your men are, how they are inter-related, their personal peculiarities, their feeling toward yourself and others, and the political organization of the plant as a whole, than to know the intimate details of production, although the latter is essential. You cannot treat any two men in the same way and get the best results from each of them. The most successful organizer and manager is the one who knows his assistants, makes allowances for their peculiarities, and makes it a point to promote personal good will among them.

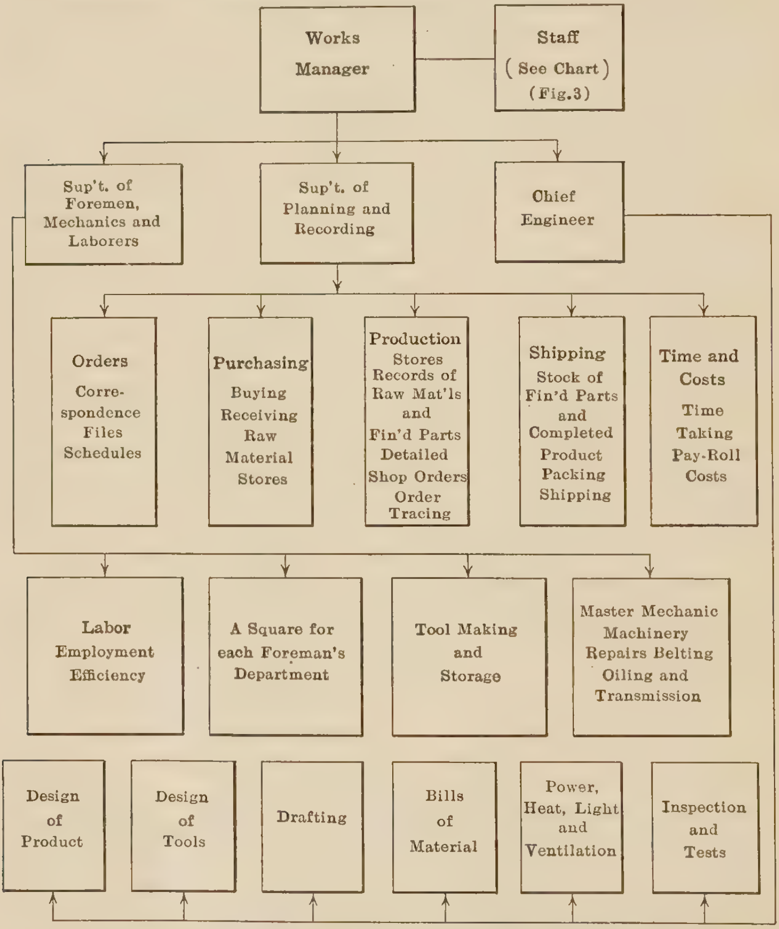
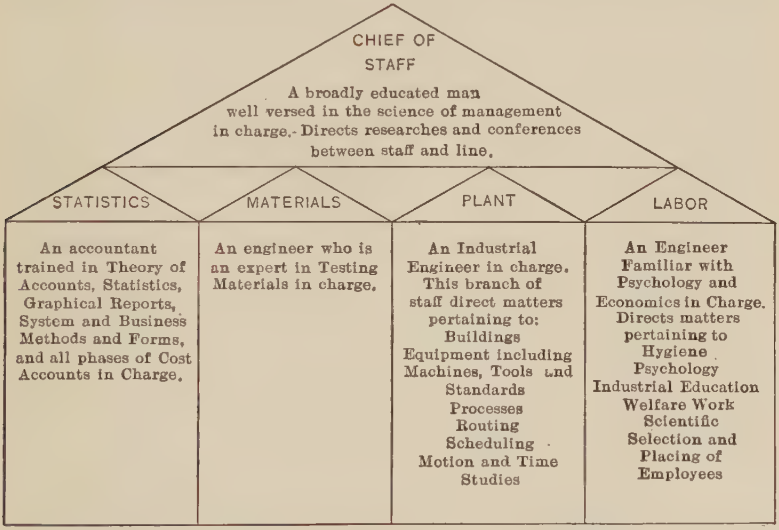

Works Manager
Staff (See Chart) (Fig.3)
Sup't. of Foremen, Mechanics and Laborers
Sup't. of Planning and Recording
Chief Engineer
Orders Corre-spondence Files Schedules
Purchasing Buying Receiving Raw Material Stores
Production Stores Records of Raw Mat'ls and Fin'd Parts Detailed Shop Orders Order Tracing
Shipping Stock of Fin'd Parts and Completed Product Packing Shipping
Time and Costs Time Taking Pay-Roll Costs
Labor Employment Efficiency
A Square for each Foreman's Department
Tool Making and Storage
Master Mechanic Machinery Repairs Belting Oiling and Transmission
Design of Product
Design of Tools
Drafting
Bills of Material
Power, Heat, Light and Ventilation
Inspection and Tests

FIG. 2.—Chart illustrating line control in a large industrial organization.

36. Specific Duties.—Specific duties must be clearly set forth not only for each group of individuals and various departments, but a schedule of individual responsibilities and routine should be prepared for the use of each individual in each department.

In addition to defining departmental and individual duties, the duties of groups and committees must be listed. Charts and diagrams should be prepared to show responsibility and interrelation of various departments, officials and committees of the organization as a whole. Similar departmental charts and diagrams should be prepared for the various departments and subdepartments. Each chart should be supplemented by such extensive, explicit, detailed instructions as are required to make it perfectly clear.

37. A Comprehensive Industrial Organization.—Fig. 2 is presented as a comprehensive conventional model organization



A broadly educated man well versed in the science of management in charge. Directs researches and conferences between staff and line.

An accountant trained in Theory of Accounts, Statistics, Graphical Reports, System and Business Methods and Forms, and all phases of Cost Accounts in Charge.

An engineer who is an expert in Testing Materials in charge.

An Industrial Engineer in charge. This branch of staff direct matters pertaining to:
Buildings
Equipment including Machines, Tools and Standards
Processes
Routing
Scheduling
Motion and Time Studies

An Engineer Familiar with Psychology and Economics in Charge. Directs matters pertaining to
Hygiene
Psychology
Industrial Education
Welfare Work
Scientific Selection and Placing of Employees

Fig. 3.—Chart illustrating staff features in a large industrial organization. The staff functions are limited to research, and recommendations. The routine is carried on by the line departments shown in Fig. 2.

embodying the best contemporary features of staff and line control. The staff functions are limited to research, investigation and recommendation. All routine is carried on by the line departments. It is strongly urged that the staff be organized as distinct from the men having to deal with regular routine, and that all staff bureaus be collectively under the leadership of a head of staff who should be a broadly educated man. We might designate him as an engineer-economist, although he may have advanced and developed through one of the branches of the organization dealing with engineering accounts, or, on the other hand, through a department dealing with men, or one dealing with machinery.

Fig. 3 illustrates the proposed staff organization under four general bureaus, namely: (1) Records; (2) Materials; (3) Plant, Equipment, and Processes; (4) Labor. The term "Bureau" is used to emphasize the distinction between these staff divisions and so-called departments. The term "Bureau," while it may be objectionable to some persons by its traditional association with the so-called bureaucratic or arbitrary red-type absolutism which went by that name in government bureaus of a former generation, has lost its stigma and seems to be well used as designating these staff branches. Briefly outlined, the functions of these staff bureaus are as follows:

38. Bureau of Statistics.—This bureau, like all of the staff bureaus, is a bureau which has no direct disciplinary control over any of the various departments which keep records. It is primarily a research and advisory bureau, the result of whose investigations and whose recommendations are brought up at such meetings of department heads and others as may have been predetermined. It is the duty of the bureau of statistics to see that records by various departments are not merely kept and stored away, but that from each set of records is secured a method of most effective analysis, so that the records of the past may be compared with the records of the present and conclusions may be drawn as to future action.

The individuals engaged in this bureau must be experts in theory of accounts, the science of statistics, the art of graphical presentation and cost accounting. The tendencies and facts indicated by an analysis of the records must be brought forcibly to the attention of all individuals whose actions, based on experience and intuition, differ from the action indicated by an analysis of figures, records and statistics. It should be the aim of an organization to make history first and then to record it. The records of matters that are done and over with should be adequate but brief. Useless statements and reports should be eliminated. Detailed cost-keeping can be and usually is over-done.

What constitutes a delightful problem for an accountant may be of no use as an aid to executive control. It is not so important to know exactly how bad a mistake has been as it is to know that mistakes are being made in time to stop them.

An important function of the bureau of statistics is to see that approximately accurate daily records are prepared which indicate quickly what the general trend of events is in each department of the plant. Direct contact with current work is brought about by the committee system, introduced by C. U. Carpenter, by which department heads responsible for the prosecution of routine work frequently meet the members of the staff bureaus.

39. Bureau of Materials.—This bureau is advisory as to the fitness of materials, as indicated by the technology of the various materials employed, with constant attention to cost reduction as well as the bettering of product. Its head should be an engineer thoroughly conversant with the testing of materials.

40. Bureau of Plant, Equipment and Processes.—This department will consider and decide upon methods of routing, scheduling, motion and time studies, preparation of instruction sheets and cards, standardization of equipment. In all of these matters the work of the staff department ends with the successful carrying out of a method recommended by it. The routine is carried on by men adapted to carry out routine work successfully. For instance, many of the decisions of this staff department are applied to the routine work of the planning or production department, which is not a staff department.

41. Routing.—This involves a study of the processes and product and the preparation of process maps for the various classes of product and the determination of most predominant paths, some of them consecutive, some of them simultaneous, together with the floor spaces, weights, bulks, etc., involved, and recommendations as to rearrangements of equipment and departments, and proposals as to building modifications and extensions. It consists further in the designation of which department, machine and class of individuals are to perform the operations indicated.

42. Scheduling.—This consists of the determination of the sequence in which all orders which are to be worked on by the various departments of the establishment are to be listed so as to determine their precedence and the methods of preparing a definite program, in order that the shop may be provided by the production or planning department with a daily schedule covering the sequence of all work for the day. Scheduling naturally divides itself into two sections, one having to do with the scheduling and tracing of an order from the time of its first receipt or issuance as part of a manufacturing program to the time it is translated into many production orders by the production on planning department, the other having to do with the scheduling and tracing of the individual production orders.

43. Motion and Time Studies.—Motion study consists of the analysis of each process into its ultimate simplest steps, and the elimination of useless or improper motions. This process is prerequisite to, and more difficult than, time study, which consists of the timing with a stop-watch of the elements indicated by the motion study. That motion study is more difficult than time study is proved by the revelations disclosed by Frank Gilbreth's application of the motion-picture camera to assembling operations. Motion study research can be applied to accounting, designing and drafting methods and equipment, as well as to mechanical and trade processes.

44. Preparing Instructions.—The results of the researches in routing, motion studies and time studies are to be taken up with the most skilled men in each process, these being the men usually detailed as demonstrators while the motion- and time-study observations are being made, due allowance being made if the demonstrator is a so-called pacemaker, and detailed instructions are to be prepared which are to be the standard practice and are not to be departed from. Proposals for different steps or methods from the standard are, however, to be encouraged through the medium of a suggestion system, and duly rewarded if they result in improvement.

The instruction sheets are to be furnished to the production or planning department for all new operations in just the same manner that the designing department furnishes the detailed shop working drawings for the designed product. In this particular respect it may be said that the staff department does, after all, come in touch with the routine work of the shop. However, having once decided on the instructions, the staff department is through with them as soon as they are working satisfactorily.

In the use of instruction cards, only absolutely necessary information should be issued, and this in the briefest possible form. There is a tendency among systematizers to require voluminous instructions to be issued to workingmen who have neither the time nor ability to read and absorb them rapidly, even if they have the inclination to do so. However, where the instructions are an attempt to present to the working man the time and motion analysis necessary to be followed by him in order to get his work out in the required time and earn his bonus, there is a good reason for statements such as "Read instructions —3 min.," "Pick up piece, 1/10 min." etc.

45. Standardization of Equipment.—This covers standardization of tools, appliances and fixtures by an expert in tooling processes, who may wish to co-operate with the motion- and time-study man or men in securing data.

46. Bureau of Labor.—This staff bureau will consider hygiene and efficiency; psychology and efficiency; industrial education and efficiency; safety organization, and devices, and development of loyalty through social and religious activities. The head of this staff bureau may appropriately be an engineer with training in industrial psychology and economics.

47. Hygiene and Efficiency.—This branch will take up such matters as adequate provisions for pure and abundant drinking water, proper sanitary and toilet arrangements, first-aid-to-the-injured, eye-strain due to poor light, poorly directed light, glare, lassitude due to impure air or too dry air, discomfort due to temperature being too hot or too cold, together with the installation of proper remedies and the maintenance of proper conditions.

48. Psychology and Efficiency.—Careful researches must be made as to the presence of avoidable fatigue due to such factors as monotony of occupation, long maintenance of a single position, constant repetition of certain movements, lack of conversation, studies of temperaments of eligible candidates for promotion, so as to give due consideration to these characteristics of future gang leaders, assistant foremen, foremen and other officials, since irascibility and lack of sympathy on the one hand and lack of stamina and vigorous discipline on the other hand, may seriously interfere with the efficiency of a newly appointed petty line officer.

49. Industrial Education.—This department not only provides for training of apprentices, but must provide means to each individual, so far as possible, for attaining greater efficiency. There must be systematic selection of each individual, and his systematic training for further development must be carefully planned. Developing the individual will automatically provide for the development of leaders. This department will handle such matters as the shop library and suggestion system. If we expect our men to think clearly, to do the right thing in emergencies and to prepare themselves for advancement in our service, we must give them the benefit of the experience of experts by a systematic course of instruction.

50. Development of Loyalty.—Systematic and continuous efforts must be made to make each individual's work inspiring and to get each man interested in his work. The system of promotion must be such as to afford numerous examples whereby ambition may be preserved. Lectures on the history, processes and appliances of the company's product are a factor in the development of loyalty. An active work in the interests of good fellowship and social democracy will tend toward fair play for all and the avoidance of sharp practices in the dealings of employees with each other. The efficiency of men loyal to a common cause, and to one another, is very much more productive than their mechanical efficiency alone, and an organizer should do everything in his power to make conditions favorable to the growth of this spirit. The fundamental bases of loyalty are adequate compensation and personal recognition. If these are lacking, betterment work can affect only animal efficiency.

51. Line Organization.—Fig. 2 is a conception of a model comprehensive conventional line organization. It will be noted that the staff is put on an equal level with the works manager, but that it works through him and his line organization. The line organization is divided into three subdivisions. These divisions are under the leadership, respectively, of the chief engineer, the superintendent of planning and recording, and the superintendent of foremen, mechanics and laborers.

52. Progress of an Order.—The table in Fig. 4 shows how an order passes through the various departments under the supervision of the line departments. The numbers in front of each division indicate the sequence of steps in the progress of the order. The superintendent of planning and recording has control over the manufacturing program and through his scheduling department controls the daily order of work. The methods of scheduling are determined by the staff organization. The routine of the scheduling of the regular work is carried on by the line organization.

There may be few industries large enough to require fully manned departments for all of the activities indicated. No matter how small the industry is, however, it must be analyzed minutely and the above principles of the science of management applied in its organization and operation. A department need not consist of many men. It may consist of but one man, or one man may conduct several departments, but his specific

PROGRESS OF AN ORDER

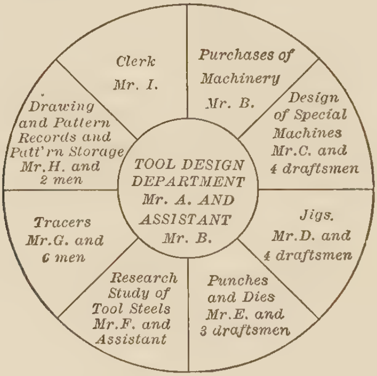
Departments in charge of Chief Engineer	Departments in charge of Supt. of Planning and Recording	Departments in charge of Supt. of Foremen, Mechanics and Laborers
	Order Dept. 1. Order entered. 2. Order scheduled and followed to tracer in production dept. This following up by schedule clerk includes processes 3 to 9 inclusive.	
Designing Dept. 3. New designs made. Drafting Dept. 4. Drawing list made. 5. New drawings made.	Production Dept. 6. Stores records checked and requisitions made on purchasing dept. Purchasing Dept. 7. Purchases entered. 8. Receiving dept. notified. Production Dept. 9. Detailed shop order prepared including: 9a. Routing. 9b. Instruction cards. 9c. Tool lists. 9d. Time standards. 9e. Order of work. 9f. Tracing of work through shops.	
11. Inspection Dept. Inspection and tests.		10. Work in shop department.
	12. Time and costs. 13. Shipping.	

FIG. 4.—Progress of an order through the line departments of an industrial establishment. Note that routine work is not handled by the staff bureaus, whose fields are research, conference, and recommendations.

duties, routine and responsibilities must be accurately determined and carried out, otherwise the industry is being carried on in a slip-shod, inefficient manner. In other words it is unorganized and the basic principles of the science of management are not being applied.

53. Applying above Principles to Smaller Industries.—The above outline is intended to be sufficiently comprehensive to apply to an industrial organization of considerable magnitude. Extensive as it may seem it is not nearly as elaborate as the complete organization chart of a large railway system.

In making a study of the existing organization of the planning and recording departments, the first step is to write out a functional list, without names of individuals, showing the duties of each department and of each man in each department. With this functional analysis as a basis, there can be built up such as impersonal functional list or chart as appears best adapted to the company's conditions. The complete removal of the personal element is absolutely essential. After the new chart has been prepared, comes the selection of each man, of that man above all others that will best fit each place.



Clerk Mr. I.
Purchases of Machinery Mr. B.
Design of Special Machines Mr.C. and 4 draftsmen
Jigs. Mr.D. and 4 draftsmen
Punches and Dies Mr.E. and 3 draftsmen
Research Study of Tool Steels Mr.F. and Assistant
Tracers Mr.G. and 6 men
Drawing and Pattern Records and Patt'rn Storage Mr.H. and 2 men
TOOL DESIGN DEPARTMENT Mr. A. AND ASSISTANT Mr. B.

FIG. 5.—Departmental internal organization circle.

After the listing of each distinct departmental function, outside of the direct productive departments as above, or including the direct productive departments also, the next process is the merging together of such departments as must necessarily be combined in establishments of moderate size, which cannot carry a list as long as the above, of distinct departments. The distinct listing of functions is advisable, however, whether each function represents a department or not. The next steps in this direction would be the charting, first of the organization as it now exists, and secondly, of any improved or ideal organization which it is hoped to secure.

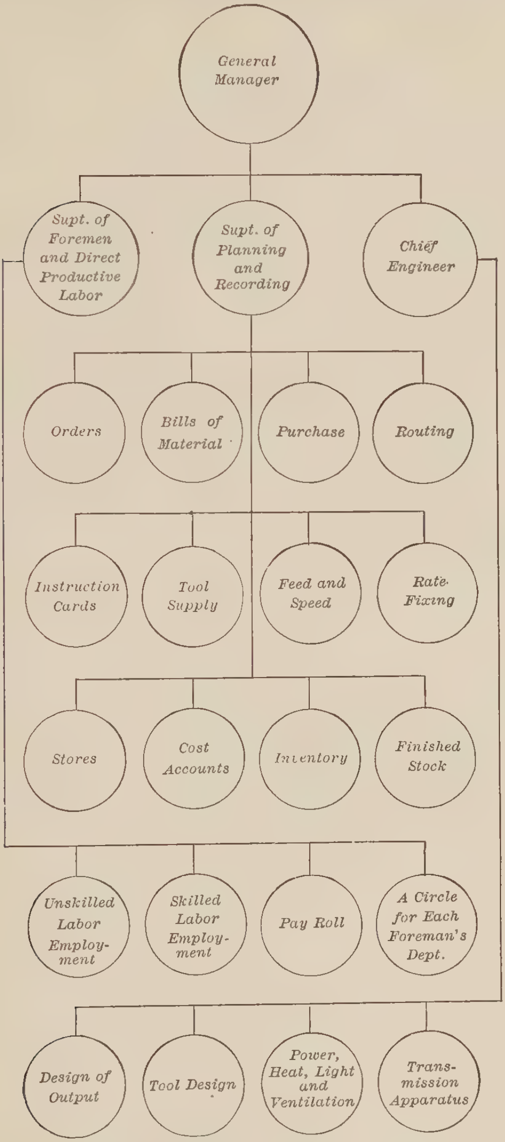


FIG. 6.—General organization chart.

54. Types of Organization Charts.—There is probably no better method of charting than that of circles connected by lines or arrows, each circle representing a department, and the lines or arrows representing either their subordination to each other, or, by some different type of line or by using a separate chart, representing also their geographic juxtaposition, or the manner in which the work is handled first by one department and then by another. This method of charting was first used by Messrs. Garcke & Fells, and adopted by J. Slater Lewis and subsequent investigators into the matter of factory organization. Fig. 5 is an example of this method of charting applied to internal departmental organization. This example will suffice to show the method of division of duties coming under each functional head. I believe it to be a good plan for each department to have a chart showing the organization within that department, as well as a chart of the general factory organization, so that each man may see his place and not labor under any delusions as to his authority or his prospects. In Fig. 6 is presented a form illustrating this method of showing the general organization scheme. The scheme here shown is presented merely as an example for illustration.

REFERENCES

Ennis: "Works Management," Chapter VIII.
Parkhurst: "Applied Methods of Scientific Management," Chapter I.
Going: "Principles of Industrial Engineering," Chapter III.
Taylor: "Shop Management," Paragraphs 233–240.
Emerson: "Efficiency" Chapter IV.
LaSalle Extension University: "Business Organization," Chapter V.
Knoeppel: "Maximum Production," Chapter II.

CHAPTER IV

TYPICAL FACTORY ORGANIZATIONS

55. Existing Organizations Widely Different.—Factory organizations as they exist to-day present as wide a range of physiological structure as the whole animal kingdom. We can well compare some establishments to a mass of protozoa. Others may be likened with justice to the highest orders of vertebrates, with their complex systems of organs, muscles, and nerves. In the lower and extinct types of animal life we find beings with few organs, and often with the same organ many times duplicated. As the ages have passed, these types have decreased in number, being unable to resist the more highly developed classes. In the higher types we have no duplication of vital organs. The same is true of factories. The crude types, lacking in some organs, and with much duplication of functions, must pass away and give place to the vertebrate type, with its higher physiological development.

It is evident that the designing of organizations for the newer, larger, and more complex establishments becomes of constantly greater importance.

56. Importance of Charting.—In the great majority of manufacturing establishments the company officers are far more conversant with the details of financing, accounting, and selling than they are with those of manufacturing. From time to time questions of business policy arise which have an intimate connection with cost of production, time of delivery, stock of raw material, stock of finished parts, condition of work in process of manufacture, and similar matters.

At such times many officers realize that whereas in the settlement of questions of financing, accounting, and selling they had clear-cut records at hand to guide them in forming policies, on the other hand, when it came to questions involving the factory itself, they were dependent wholly upon opinions of superintendents or foremen, these opinions having no firmer foundation than intuition. The realization of their helplessness and the absence of reliable and accurate knowledge of manufacturing conditions has been an incentive to progressive officers of manufacturing establishments to devise more thorough systems of executive control of the factory. More and more it has been appreciated that some graphic method of showing inter-departmental relations is necessary if responsibility is to be placed.

57. The Works Manager's Position.—The most successful factory organizations are those in which all departments having to do with production in any manner whatever are subordinate to and responsible to one general head, the works manager, who has a thoroughly competent assistant ready to take the chief's place at any time, and who is recognized as the acting works manager in the absence of his superior. This form of control is a typical characteristic of the most successful manufacturing organizations. There must be no paths whereby company officers or any other departments in any way deal with departments responsible to the works manager except through the works manager's office.

In manufacturing, next in importance to the centralization of executive authority is clearly defined departmental lines, with a responsible head and assistant head for each department. The business which has its factory departments so organized that each department head is responsible to the works manager, without any intervening bosses, will be far more free from internal dissensions than one in which this is not the case. Yet one hears of company officers gleefully telling how they are "keeping them guessing," in referring to their most capable men and the question of where they stand in the organization. There are corporations who deliberately pursue this course as a fixed business policy, giving as their reason that they do not want to give any man too much power. Another reason for failure to establish clear-cut departmental lines lies in company officials making promises and offers to high-grade men in order to get them into their employ—promises they know they cannot fulfil on account of numerous similar promises to other employees. Such policies are suicidal to a business in the long run.

A few examples of successful organizations of factories are illustrated in the accompanying charts.

58. Organization Chart of a Typewriter Factory.—Figure 7 shows the factory organization of the Remington Typewriter Co., of Ilion, N. Y. This company is engaged in what is generally

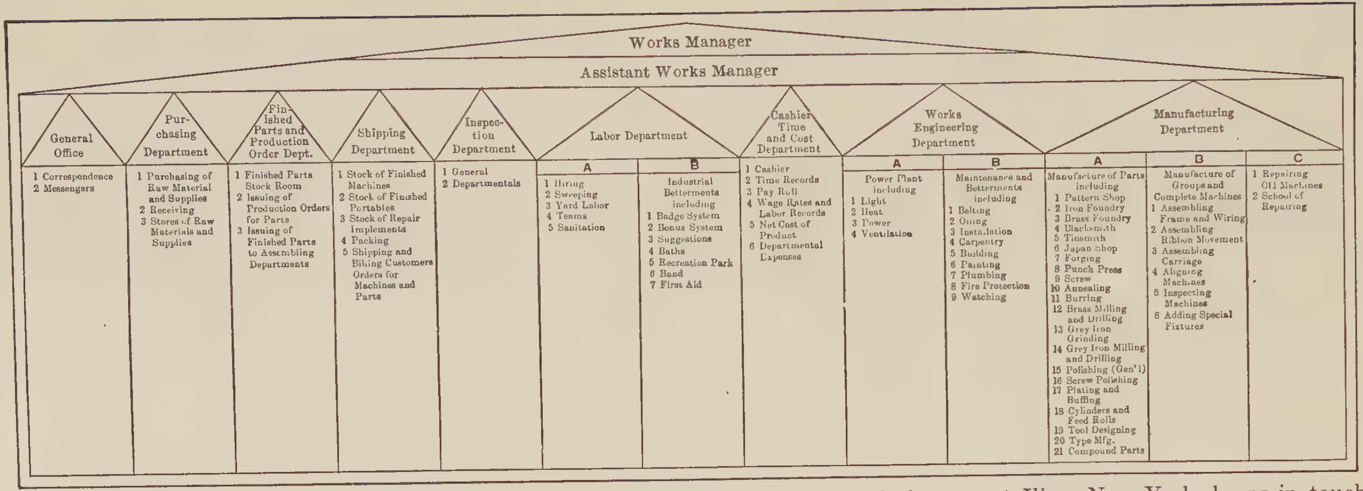


Fig. 7.—Showing how the works manager of the Remington Typewriter Company's factory at Ilion, New York, keeps in touch with the various departments of the plant. This organization is typical of a plant engaged in a "straight manufacturing proposition"—work in which the output is fixed and standardized; hence designing and drafting do not appear in the list of departments. In this plant the works manager has direct supervision over each department. Shipping, purchasing, time- and cost-keeping departments are all responsible to the works manager or assistant works manager.

called "a straight manufacturing proposition." That is to say, things are not built to order, but the product is fixed and thoroughly standardized. Hence designing and drafting do not appear among the list of departments under the control of the works manager. It will be noted that there are nine general departments, viz: (1) General office of works; (2) Purchasing; (3) Finished parts and production orders; (4) Shipping; (5) Inspection; (6) Labor; (7) Cashier (including time and cost keeping); (8) Works engineering, and (9) Manufacturing. The head of each of these departments is directly responsible to the works manager and assistant works manager and no one else.

It is noteworthy that this company has put under the works manager such departments as shipping, purchasing, time and cost keeping. In the great majority of American shops, where principles of good organization have not become well recognized, we find the head bookkeeper or some company officer looking after purchasing, time and cost keeping and shipping, leaving all the rest of the functions departmentalized, as shown on this Remington chart. The shop Superintendent therefore, in addition to being the head of the manufacturing department with all its subdivisions, must also look after stock and production orders, employment, inspection, works engineering, power plant, and so on. Being badly over-worked he usually has an assistant Superintendent under him and a general foreman under the Assistant Superintendent, shop clerks under the general foreman, and so on, each being looked on as more or less of a "boss" in the works, but without clearly defined limits of authority.

The type of man usually filling the position of shop superintendent in the average American shop is often not capable of filling the broader position of works manager. Frequently company officers, though capable of financing, accounting and selling are also incapable of acting as works managers. Most shop superintendents when relieved of the many duties which are shown segregated in this chart make excellent heads or superintendents of "manufacturing departments."

Another interesting feature of the Remington chart is the division of the labor department into two branches, one having to do with hiring, employment records, and general labor, and the other having to do with industrial betterments. This permits of combining a good hiring boss, on the one hand, and a trained welfare man or sociologist, on the other, who can pool their abilities to the best end for practical results.

It will also be noticed in the Remington chart that all production orders emanate from the finished parts and production order department. No factory operation of any sort whatever, whether for stock, upkeep or betterments may be made without the proper order issued by this department. The stock of parts required for manufacturing purposes is entirely separate from stock for shipping and repair purposes. Also the stock of raw material is under separate jurisdiction, being under the purchasing department. All stocks, in each of the above classes, are regulated by definitely established maximum and minimum quantities.

59. Chart of an Automobile Factory.—Fig. 8 illustrates the factory organization of the National Motor Vehicle Co., of Indianapolis, Ind., as it existed some years ago when the writer was Superintendent. It will be noted that the title of Superintendent in this shop carried with it many of the duties which at the present time would be assigned to the works manager. This type of factory is one in which designing and drafting comes to the front to some extent although not quite as prominent as in a works building special machinery to order or building a line of varied engineering product. Here the product is redesigned or modified annually and there is more or less redesigning and experimenting throughout the season. It will be noted that we have one general circle entitled company officers. The proprietorship of this company centered itself in two company officers who had not definitely divided responsibility between themselves, although we had a very well-mapped-out chart from the company officers downward through the three-fold control exercised respectively over the purchasing agent, superintendent and the chief engineer in charge of the designing department. Various department heads were apt to receive conflicting instructions from the two proprietors previous to charting the organization. The posting of the organization chart had the effect of eliminating most of these conflicts. Glancing at the chart, we will note that the purchasing department had charge of shipping and receiving, this work being divided into three groups: (1) Shipping, (2) Receiving, (3) Stock of raw material and purchase parts. The superintendent had charge of not only the manufacturing department but also the produc-

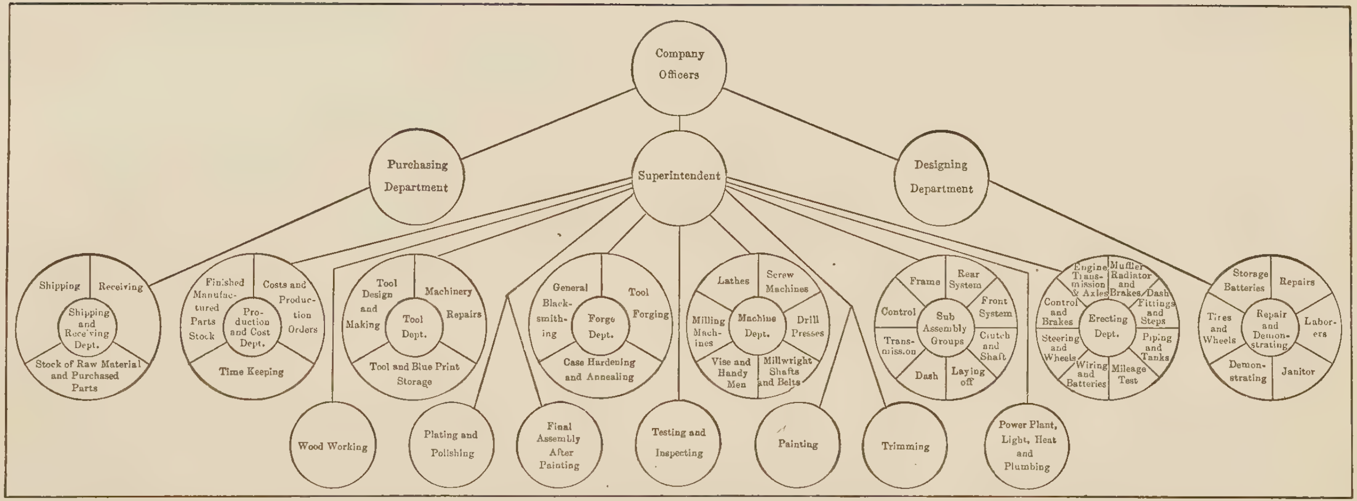


FIG. 8.—Compared with Fig. 9, this factory organization of the National Motor Vehicle Company of Indianapolis typifies a plant in which designing and drafting play a most prominent part. In this organization the superintendent has many of the duties assigned to the works manager in Fig. 9. Since the product of the plant is modified annually, there is more or less new designing and experimenting throughout the season. Fig. 9 indicates the triangle method of graphic analysis, while in Fig. 10 the organization has been worked out on the more familiar circle basis.

tion and cost department, as well as the works engineering including power, light, heat and plumbing. The production and cost department had three divisions: (1) Production orders and cost, (2) time keeping, (3) stock of finished manufactured parts. The manufacturing departments were as follows: (1) wood-working, (2) tool department, (3) forge department, (4) machine department, (5) sub-assembly groups, (6) erecting department, (7) plating and polishing, (8) painting, (9) trimming, (10) testing and inspecting, (11) final assembly after painting. Subdivisions of some of the more prominent manufacturing departments are indicated on the chart; for example, the tool department has three subdivisions, viz: (1) Tool designing and tool making, (2) tool and blue-print storage, (3) machinery repairs. The forge department has three subdivisions, (1) General blacksmithing, (2) tool forging, (3) case hardening and annealing. The machine department is also subdivided thus: (1) Lathes, (2) screw machines, (3) drill presses, (4) millwright, shafts and belts and oiling, (5) vise and handy men, (6) milling machines. Of course there were some other machines including planers, shapers and boring mills in the department called the lathe department. The circle entitled sub-assembly group has eight subdivisions: (1) Men working on frames, (2) men working on rear systems, (3) men working on front systems, (4) men working on assembling clutch, shaft and universal joint groups, (5) vise hands working at laying out and high grades of vise work, (6) wiring and dash, (7) transmission, (8) steering head and control parts attached to same. The erecting department is shown in eight subdivisions: (1) Engine, transmission and axles, (2) control and brakes, (3) steering wheel, (4) wiring and batteries, (5) muffler, radiator and brakes, (6) dash, fittings and steps, (7) piping and tanks, (8) mileage test. It will be noted that the repair work and demonstration is put under the jurisdiction of the designing department, the idea being that in this manner the chief designer will keep in very close touch with the performance and wear of the machines.

60. Chart of an Engineering Works.—Fig. 9 shows the organization of a strictly engineering business as laid out by the writer for the conditions existing at the Western Gas Construction Co., of Fort Wayne, Ind. Here the designing department takes the initiative on all orders since practically all production is built to order. The company is engaged in contracting for gas works. The chart covers the entire organization including accounting and selling. The advisory board, which

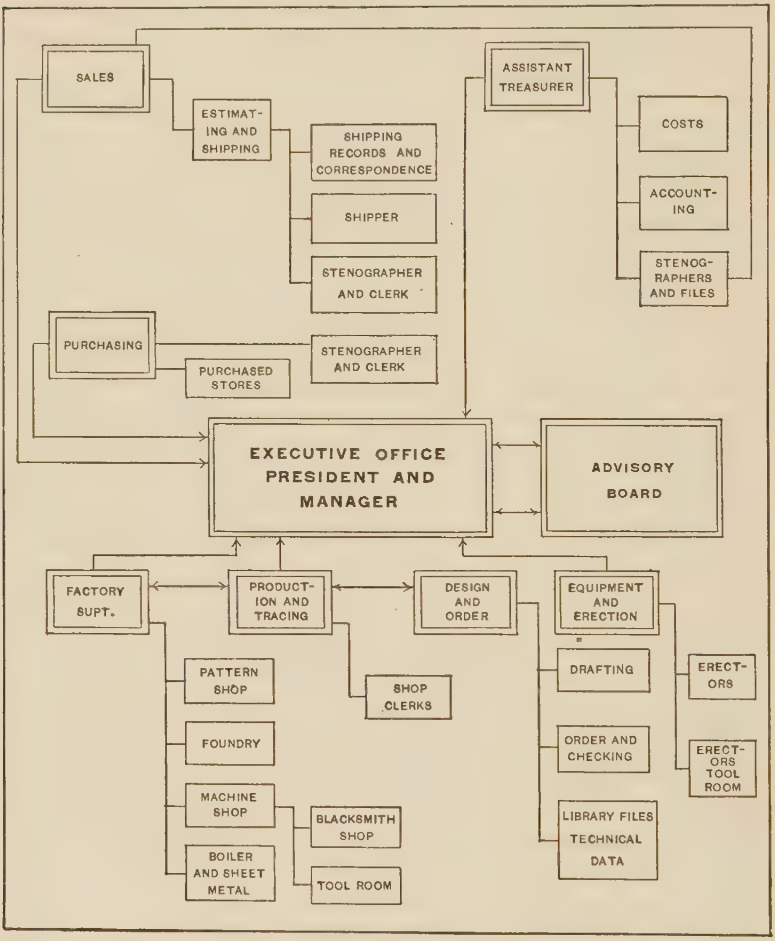


FIG. 9.—Showing the organization of a strictly engineering business conducted by the Western Gas Construction Company of Fort Wayne, Indiana. Here the designing department takes the initiative on all orders, since practically all product is built to order. The chart covers the entire organization, including accounting and selling. The advisory board, which consists of heads of all departments, meets once a week and makes and receives recommendations from the president and manager, who is himself an expert mechanical engineer. In plotting this chart the rectangular method of procedure has been employed.

consists of the heads of all departments, meets once a week and makes and receives recommendations from the President and

Manager, who is himself an expert mechanical engineer. In preparing this chart a rectangular method of procedure has been employed. It will be noted that on the commercial side there are three controlling heads, each head directly responsible to the executive office. These are: (1) Head of sales department, (2) head of purchasing department, (3) assistant treasurer. The sales department it will be noted controls assembling and shipping, the purchasing department controls stores, the treasury department has control of accounts, including cost accounting and all stenographic and clerical and filing work. On the manufacturing side there are four general heads: (1) A factory superintendent, (2) head of production and tracing department, (3) head of designing department, (4) head of equipment and erecting department. The factory department has charge of the productive departments of the factory, including the pattern shop, foundry, machine shop, boiler and sheet metal shop. The machine-shop foreman has also jurisdiction over the blacksmith shop and tool room. The production department has jurisdiction over the shop clerks. The design and order department has charge of all the drafting, issuing of all shop orders and checking, library, filing and technical data. The equipment and erecting department has charge of the erection equipment, and of the erecting men, who are scattered through the world, and the erectors' tool room.

61. Chart of an Electrical Machinery Factory.—Fig. 10 shows the organization of a large electric machinery manufacturing company. It will be noted that the control passes from the stockholders, via Board of Directors and the chairman of the Board to the President, and from him through four controlling heads, viz: Comptroller, first Vice-President, Second Vice-President and Third Vice-President. The Comptroller's jurisdiction covers two divisions: (1) That of auditor, (2) that of treasurer. In the auditing department we have works accounting, traveling and claim agent, general accounting and invoice department. In the treasury department we have the legal work on collections, collecting department and credit department. The First Vice-President has jurisdiction over the works management. He exercises control over three distinct groups: (1) Head of engineering and his assistant, (2) purchasing department, (3) manager of works. The Second Vice-President exercises his control over two distinct groups: (1) Sales, (2) Publicity, including (3) shipper,

(4) welfare and employment department. Each division superintendent has jurisdiction over the general foreman and the general cost clerk of his division.

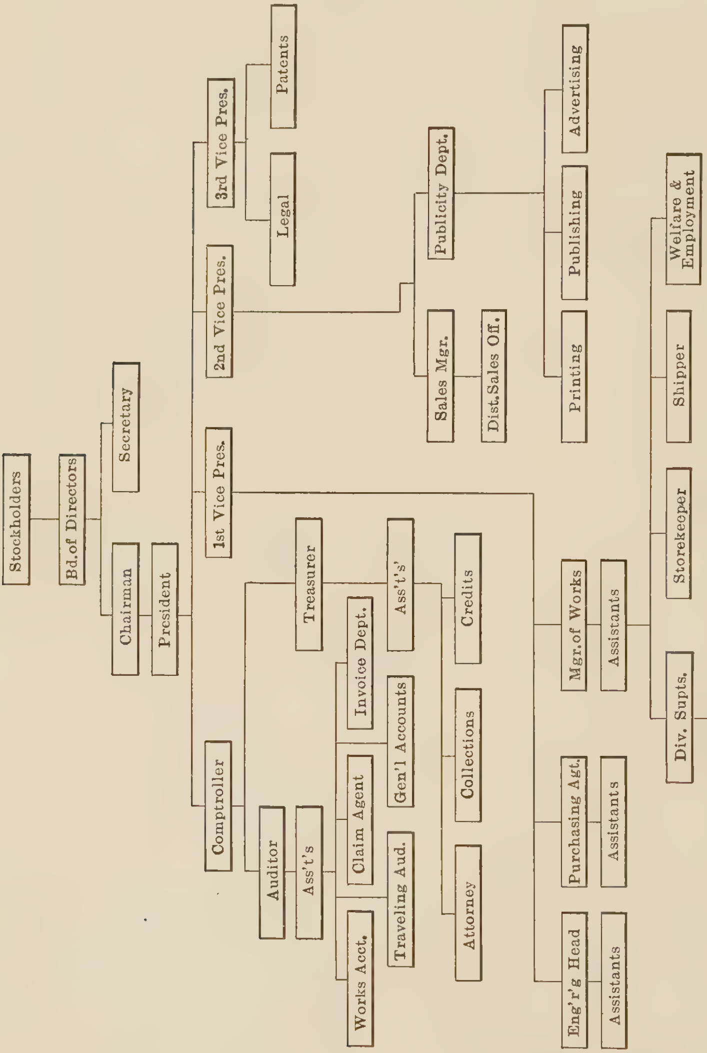


Fig. 10.—Organization of a large Electric Machinery Manufacturing Company.

The Second Vice-President has control of selling and advertising, he exercises his control over two general heads: (1) Sales manager, who has control of the various district sales offices, (2) publication department, which has control over the printing, publishing and advertising departments. The Third Vice-President has jurisdiction over two branches: (1) General legal department, (2) patent department.

62. Chart Showing the Functions of the Planning Department.—Fig. 11 shows how the planning department relieves the shop foremen of handling many details which they are expected to look after in the unorganized shop. Before an order goes to the

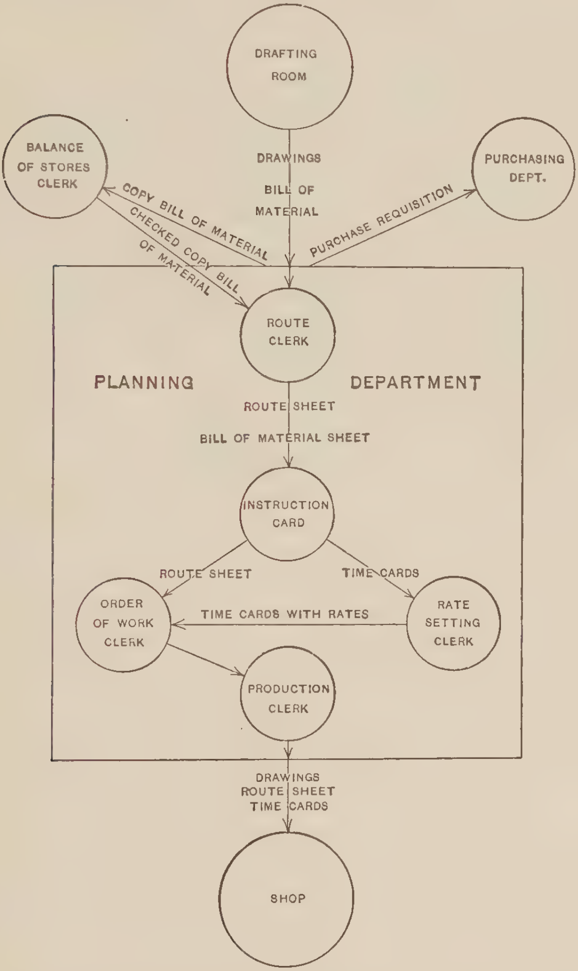


FIG. 11.—Chart prepared by C. W. Adams of the Link Belt Mfg. Co. and published in *Factory Magazine*, illustrating the functions of the planning department.

shop it goes first to the drafting room who see that all drawings are provided, such drawings for shop purposes being usually simplified to include only such references and dimensions as are necessary in the shop. The drafting department furnishes a complete bill of materials. The bill of material goes to the balance of stores clerk who makes any purchase requisitions necessary and also indicates what parts are in finished stock. The checked copy of the bill of material goes to the route clerk who indicates the process-map through the factory. From him it goes to the instruction-card man who indicates the detailed operations entailed. From him the bill of material, route sheet, and instruction cards go to the rate-fixing clerk who indicates the standard times. Thence the order and all accompanying papers go to the order of work clerk who sees how it is to fit into the manufacturing program and the schedule of work to be done. Thence it goes to the production clerk who sees that the various work orders are properly put into the shop in proper sequence and properly followed up.

REFERENCES

Arnold: "Factory Manager," pps. 117, 236, 275, 323.

CHAPTER V

FACTORY ACCOUNTS

63. Accounts Required by Modern Management Different from Old Customs.—There are certain accounting methods in connection with modern management which vary from old-fashioned accounting methods, yet whose introduction is absolutely necessary before the industrial manager can get a correct and prompt survey of cost of production.

Inasmuch as these methods are different from those formerly in general use by bookkeepers who had obtained their training in business colleges, the industrial manager is apt to have difficulty in getting them installed in cases where he does not have direct supervision over the bookkeeping department.

64. Double-entry Principles to be Applied to Cost Accounts.—Cost records are always most satisfactory and intelligible if they are constructed on the basis of the theory of double-entry bookkeeping. To meet these requirements we need merely to bear in mind that in double entry we debit what we receive. When we receive nothing we debit the person with whom we are transacting business. We credit what we give. When we give nothing we credit the person with whom we are transacting the business. Another fundamental principle which is the basis of all trial balances and balance sheets is that total debits must equal total credits. According to Hatfield the fundamental equation of double-entry bookkeeping may be stated in the form:

Goods account (debit) = proprietorship account (credit).

This equation may be expressed in somewhat more complete form as follows:

Assets (debit) + negative proprietorship accounts (debit) = capital account (credit) + profits (credit) + debts (credit).

Resources and losses are always a debit; liabilities and gains are always a credit.

65. Controlling Accounts.—Accounts which involve a prepayment or anticipation of an expense or a series of expenses, to be adjusted exactly at certain definite fiscal or financial periods, are designated as controlling accounts. Controlling accounts play an important part in connection with cost-keeping. A single expense account which may be a general controlling account may receive summarized periodic entries from a considerable number of subdivided detailed expense accounts which serve to assist the cost-keeper in determining as far as possible the expense burden factors, of every product and every service.

66. The Three Fundamental Cost Accounts.—The old custom provided three basic cost accounts, which with some modifications still constitute the basis of modern cost-keeping. These accounts were designated as "Material," "Labor," and "Expense."

67. Subdivision of These Accounts and Monthly Closing.—One of the important changes is that instead of having the accounting department carry only the three fundamental accounts mentioned, new accounts have been substituted as follows, namely, "Raw Materials," "Material Burden," "Direct Labor," "Labor Burden," "Expense Burden," "Work in Process," and "Finished Stock."

68. "Raw Material Account."—This account is debited as material is received, with the amount of its cost as per invoices, and is credited with the total charges to "Work in Process" for all materials drawn for work in process, per orders on store-room. The debit balance should represent the cost value of raw materials on hand at the opening of each period, which should be monthly, the account being closed monthly, or by four-week periods. "Material Burden" is a general account which is debited with the monthly or periodic totals of all costs of carriage on materials received, including freight, express, and drayage, cost of buying, including purchasing department salaries and expenses, cost of storing and handling, including all store-room salaries and expenses, as well as the monthly total of all salaries and wages paid to receiving department clerks, and laborers' time spent in hauling and placing materials received into the store-rooms.

"Material Burden" account is credited with the burden amounts charged to "Work in Process" account. These charges are usually on the basis of percentage-on-raw-material-cost, based on the ratio of the "Material Burden" account during the past period or several periods to the "Raw Material" account during the same time.

69. "Work in Process" Account.—This account is charged with all materials drawn for work in process per orders on storeroom, which have been credited to "Raw Materials" account, as well as with all "Material Burden" items which have been credited to "Material Burden." It is also charged with all Direct Labor charged to production orders during a given period as well as the Expense Burden. This Expense Burden may be determined by a number of alternate methods as described under the heading of "Methods of Allotting Expense Burden." If the Expense Burden includes in addition to Indirect Labor, also all other expense factors, there will be no further charges to Work in Process, but if the expense burden is divided into different kinds of expense factors, such as "Indirect Labor Burden," "Machine Burden" and "General Expense" burden, these will also have to be charged to "Work in Process." "Work in Process" is credited with the total of all orders as soon as finished, or in other words just as soon as they become "Finished Stock."

70. "Finished Stock" Account.—This account is charged with the total of all work in process just as soon as an order is transformed from work in process into a finished order. "Work in Process" account is credited with the same amount. "Finished Stock" is credited with the manufacturer's cost price as established for the various articles to be made, whenever any articles are shipped. This "Manufacturer's Cost" price is then made the basis of operations of the selling department. "Manufacturer's Cost" price may be slightly higher than the sum of "Raw Material," "Material Burden," "Direct Labor," "Indirect Labor," "Machine Burden" and "General Expense Burden," in order to allow for slight fluctuations in cost. Any apparent profits accumulated in this way can be transferred to reserves, for meeting depreciation of plant and equipment, once a year. Fig. 12 illustrates graphically the theory of cost accounts as above indicated in its simplest form.

71. Methods of Allotting Expense Burden.—*Percentage on Wages.*—The oldest method and the one still in most general use is the percentage on wages method established by finding the ratio in percentage, which the sum total of Indirect Labor, "fixed charges" and all other expense accounts in a given period bears to the sum total of Direct Labor in the same period. Its greatest weakness lies in the fact that it over-charges high-priced labor which may use shop and equipment and share running expenses only a short time, and under-charges low-priced labor which may use shop and equipment and share running expenses a long time, in creating a direct-labor cost of the same dollars-and-cents value.

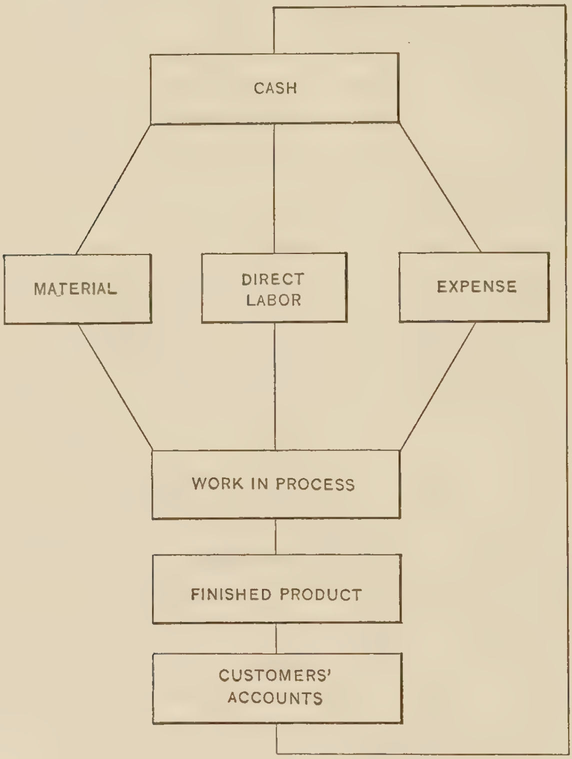


Fig. 12.

The "fixed charges" include the allottments from constant expenses such as rent, interest, insurance, taxes, general officers' salaries, etc.

72. Hourly Expense or Man-hour Rate.—A more recent method, and the one which is in use by all machine-tool builders using the uniform cost-accounting methods recommended by the National Machine Tool Builders' Association, is the hourly expense rate obtained by dividing the sum-total of all indirect labor, "fixed charges" and expenses during a given period by the sum total of direct-labor hours in the same period.

73. Separate Man-hour Departmental and General Rates and Hourly Machine Rates.—A third method, probably in the least general use, but destined to become far more widely used is one which establishes (a) an hourly rate for each department, local to that department (b) a general hourly shop overhead rate (c) an hourly rate for each machine or group of machines. Rates a, b and c are mutually exclusive and the sum total of all expenses allotted from these three channels must approximate the total of all indirect labor, "fixed charges" and all other expenses in the same period. Inasmuch as the charges to "Work in Process" and corresponding credits to the various expense accounts during a given period are the results of calculations based on averages of preceding periods, the exact balancing in order to close the expense accounts must be left to an adjustment entry which may result in either a debit or credit to the expense account at the opening of the next period. If a considerable item, this adjustment entry may demand a modification of the rates for allotting expense burden during the next new period.

The establishment of local departmental burden rates affords the proper basis for comparing local expenses from month to month, as well as holding down costs on product which passes through departments having low local burdens.

74. Method of Establishing the Hourly Machine Rate.—A number of different considerations enter into the establishment of the hourly machine rate. Among these are the following: (1) The interest and depreciation on the purchase price of the machine; (2) the annual cost of repairing the machine and keeping it supplied with lubricants and cutting tools, etc.; (3) the floor space occupied by the machine and the stock lying about it; (4) the power consumed by the machine.

With the previous year's expense accounts as a basis, an estimate is made of the total maintenance of all machines. Out of this grand total or budget, each machine tool is given a certain definite allowance or allotment for the coming year. A card is then written out for each separate machine tool, and after determining approximately the number of hours that the machine will run during the year, its hourly operating rate is established for the next year by dividing the total budget by the estimated hours that the machine is to be used. Every time that the machine is used, it is credited with the amount it earns as its hourly rate, the amounts being posted on the card record for that machine tool from the cost department's records, showing amount or semi-annual period it is found likely that the postings on any card will over-run or fall short of the amount allotted the given machine changes must be made in the individual machine rate. The exact balancing at the close of a year will be left to an adjustment entry which may result in either a debit or credit to the machine expense account at the opening of the next period. With careful allotment of rates these adjustment entries will be relatively small and required only in order to make an exact balance at closing.

75. Segregation of Works Expenses from Selling Expenses.—It will be noted that at the outset it was recommended to keep out of General Expense account, items relating to "Material Burden," such as transportation, hauling, purchasing and stores. Similarly all expenses of the finished stock-room and all shipping department expenses outside of outgoing freight charges can be kept in a separate account, which is entered into the general total for determining the Expense Burden.

All distinctly selling expenses should be kept separate and the sales department made to show a profit on the basis of the difference between Manufacturer's Cost and Selling Price. Administrative expense which is neither a direct charge to Works Management nor Selling, may be equally divided between Manufacturer's Cost and Selling Cost.

76. Detailed Cost Statistics and Records.—Very little has been said in this discussion as to the forms for posting these records. The nature of the business will determine whether these records are to be based on unit prices per quantity of output, per variety of output, or per individual lot or item, whether each individual item is to have its cost figured regularly or at intervals. Most books on cost-keeping are filled with examples of forms for recording the statistical data. A minimum of stress is laid on these features in this discussion in order to bring out more strongly the importance of the foregoing general principles.

The extent to which detailed costs are obtained depends very largely on the nature of the business. In some industries it will be satisfactory to obtain costs by processes, in other industries by classes or groups of products, in others by weight or bulk and in still others by departments or by machines.

77. Proper Classification of Expenditures.—The first thing for an accountant to determine with regard to an expenditure is whether it is a charge to assets or to revenue. We must determine whether the expenditure was (a) for materials, supplies or labor for regular production (b) for materials, supplies or labor for special production which is to be charged to customers (c) for distinct additions to plant or equipment (d) for maintenance of existing plant or equipment, or (e) for replacement of worn-out plant or equipment.

If the system of accounts heretofore indicated is in use, which shows the value of raw materials, work in process, and finished stock each month, then there is apparently no need for the carrying over of heavy purchases under (a) and (b) to be diffused over several months, as the month's operating profits and losses are easily determinable and quite independent of whether heavy purchases have been made in any one month or whether the purchases have been unusually light. In the matter of items under class (4), namely the replacement of wornout plant or equipment, such items would be paid for out of depreciation fund if such exists. If such does not exist and the expenditure is of considerable magnitude, the expenditure should be diffused over such period as may be determined on as fair to ordinary production.

It is frequently the case that good discrimination is exercised in properly distributing expenditures for which there is a supplier's invoice whereas no such discrimination is used in distributing expenditures of the materials and labor of the industry, so that the apparent cost of production varies widely, whereas if expenditures were properly allotted there would be no such apparent discrepancies.

78. Detailed Cost Posting Methods.—The methods, records and forms required for finding and posting costs are discussed fully in a later chapter on The Cost Department.

REFERENCES

Going: "Principles of Industrial Engineering," Chapters V and VI.
Humphreys: "Lecture Notes on Business Engineering," pages 498–510.
Day: "Accounting Practice," Part II.
Knoeppel: "Maximum Production." Chapters III and IV.
Church: "Expense Burden."
Brisco: "Economics of Business," Chapter VI.
Webner: "Factory Costs, Parts IV and V.
Evans: "Cost Keeping and Scientific Management," Chapters I to IV.
Redfield: "The New Industrial Day," Chapters IV and V.

CHAPTER VI

DEPARTMENTAL REPORTS

79. Purpose of Departmental Reports.—Departmental reports serve two purposes—they enable the head of each department to know conditions in his own department, and they enable the management to get in concise form definite knowledge as to each department.

The first requisite of a departmental report is that it serves some really useful purpose. This fact is often lost sight of. In some establishments, reports are made covering data which have very little if any practical value. This is a danger which must be carefully avoided. Whenever a works manager finds reports accumulating on his desk which he finds he passes by week after week, without drawing any useful information from them, he would better discontinue such reports altogether.

On the other hand, there is no better way of keeping in intimate touch with the whole field of a large establishment than through the medium of well-planned periodic reports. Just what should such reports cover? The purpose of this chapter is to determine methods of furnishing classified periodic information to the executive office covering existing conditions and outlook of every phase of the manufacturing side of a business.

Certain reports need to be made in order that the executive department may at any time know the exact conditions prevailing in every department. Such reports, although comprehensive, should be condensed. Hence, the method of preparation may, in certain departments, require that department to keep detailed records which can be referred to if necessary in explaining the summarized information in the reports.

80. Bureau of Statistics or Records.—The duty of determining the nature of the departmental reports, as well as how these reports are to be condensed or transformed into graphical or statistical form, is best placed under the jurisdiction of a staff bureau of statistics, or in the case of a smaller concern, a single statistician. This bureau or single official should be subordinate to no one excepting the works manager and should confer with the various departments furnishing reports, explaining fully the objects sought to be accomplished.

It is recommended that any reports prepared by certain departments be returned regularly to the department from which the reports originate. It is desirable that all reports be provided with spaces where they can be checked in the statistician's office, indicating that the report has been noted, or that they be stamped in the office of statistics after having been noted and approved, and that there be a private secretary in the statistician's office who has a list of reports that should come in, with the dates on which these reports fall due. The private secretary should see that these reports are presented to the statistician's office when due, and that they are returned from there to the department concerned after having been noted, such statistical posting from them having been done in the statistician's office as may be deemed desirable.

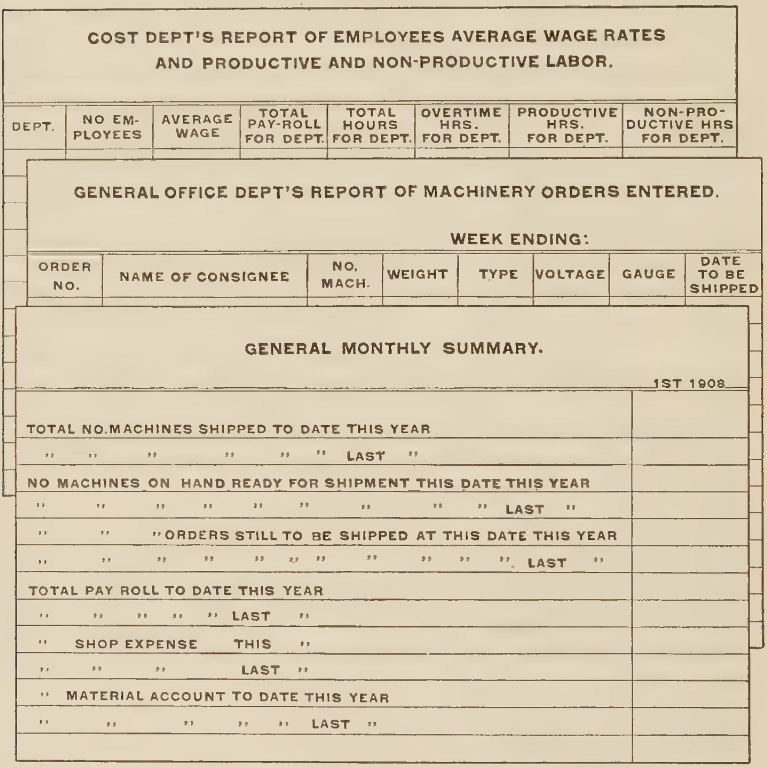
81. Typical Factory Reports.—Let us take first the general factory office. The general office of the factory receives the orders from the sales department, turns them over to the proper order departments, and advises the sales department of promise dates of delivery. This would be the routine in a factory which does not regularly ship everything from stock. The nature of the reports from the general office department to the statistician will vary with the class of manufacturing done. For instance, the reports of this department in a hosiery mill, employing 1200 people in the manufacture of a few dozen varieties of hose, will be quite different from the reports in a factory employing three hundred men in the manufacture of a dozen types of machinery, involving some ten thousand different component parts, to cover the whole line.

In general the things the works manager wants to know periodically are: First, the condition of orders; second, the condition of stock; third, the cost of product and of running of plant.

It is not the purpose of this chapter to discuss financial reports such as should be received by the general office management from the accounting department. The particular class of reports here referred to are such as are to be rendered to the works manager of a factory.

Certain reports should be made every week, and turned into the works manager's office on Monday of each week, such reports covering the week ending the previous Saturday. These weekly reports are then discussed at a meeting of an advisory board or council consisting of heads of all responsible departments.

Weekly reports of this character can be presented to the manager either in the form of a statement on a regular printed blank, or in the shape of a typewritten statement from the head of the department. A printed sheet for this purpose is shown in Fig. 13. This may be used for a general office department report of machine orders entered, a shipping department report of machines shipped, and a manufacturing department report of machines ready for shipment.



COST DEPT'S REPORT OF EMPLOYEES AVERAGE WAGE RATES AND PRODUCTIVE AND NON-PRODUCTIVE LABOR.

DEPT.	NO EMPLOYEES	AVERAGE WAGE	TOTAL PAY-ROLL FOR DEPT.	TOTAL HOURS FOR DEPT.	OVERTIME HRS. FOR DEPT.	PRODUCTIVE HRS. FOR DEPT.	NON-PRODUCTIVE HRS FOR DEPT.

GENERAL OFFICE DEPT'S REPORT OF MACHINERY ORDERS ENTERED.

WEEK ENDING:

ORDER NO.	NAME OF CONSIGNEE	NO. MACH.	WEIGHT	TYPE	VOLTAGE	GAUGE	DATE TO BE SHIPPED

GENERAL MONTHLY SUMMARY.

1ST 1908

TOTAL NO. MACHINES SHIPPED TO DATE THIS YEAR	
" " " " " " LAST "	
NO MACHINES ON HAND READY FOR SHIPMENT THIS DATE THIS YEAR	
" " " " " " " " " LAST "	
" " "ORDERS STILL TO BE SHIPPED AT THIS DATE THIS YEAR	
" " " " " " " " " " " LAST "	
TOTAL PAY ROLL TO DATE THIS YEAR	
" " " " " LAST "	
" SHOP EXPENSE THIS "	
" " " LAST "	
" MATERIAL ACCOUNT TO DATE THIS YEAR	
" " " " " LAST "	

Fig. 13 (middle), Order Report; Fig. 14 (top), Cost Report; Fig. 15 (bottom), Monthly Summary.

The general office department report is turned into the statistician's office by the head of the general office or correspondence department, and on it are listed the most important items for which orders have been received during the preceding week.

The form shown would apply to a business in which electrical mining machines are manufactured. A little ingenuity will adapt the principle involved to any other class of manufacturing.

82. Drafting Department Reports.—The second report in which the manager is interested is that of the drafting department, covering bills of material sent to the production department. For this report no printed form is necessary. It can be written on the typewriter. A list of bills of material actually sent to the production department should be followed on the same report by a list of such orders as have been received during the week requiring bills of material, but for which the bills of material have not been issued. Drafting department organization counts for a good deal in this matter, and the routine should be so fixed that all bills of material for orders received by the bill of material division of the drafting department from the general office department during any week are issued during the current week, including orders received on the last two days of the week, except for entirely new designs.

A comparison of the drafting department report of bills of material sent to the production department, with the general office department's report of machinery orders entered, will indicate what orders remain in the drafting department, for which that department has not yet prepared bills of material.

83. Production or Planning Department Reports.—The production or planning department in its turn should send a report of bills of material disposed of, and sub-orders sent to the shop like the drafting room's report. This statement requires no printed form and can be written on the typewriter. Routine, too, must here be fixed so that all bills of material received during the week are disposed of that week, with a possible exception of bills of material received on Saturday. A list of bills of material disposed of should be followed on the same report by a list of the bills of material left over. The first part of the report shows orders which have been sent to the shop for actual work during the previous week. By comparing this report with the two preceding reports it is easily understood to what extent the production department is lagging behind the orders received.

84. Reports of Finished Product.—The manufacturing or tracing or testing department's report of machines ready for shipment forms the next link in the chain of reports. This report is made by one of these departments from its records or observations, and covers all orders of any magnitude completed during the preceding week which are ready for shipment.

85. Shipping Department Reports.—On a printed form, similar to that used for the preceding reports, a report of the shipping department may be presented. By comparing the shipping department's report of machines shipped with the manufacturing department's report of machines ready for shipment, the manager can discover about how much time elapses between the shop's report of completion of an order and shipping it. Such a comparison will also indicate what part of the product goes into finished stock instead of being shipped.

86. Cost Department Report.—Another report, that of the cost department, covers the labor conditions in the factory, and is one of the most important. The printed form for this report is shown in Fig. 14. This report, considered by men who have had an insight into manufacturing, enables them to feel the pulse of the manufacturing department. Considered in connection with the previous reports, it forms the basis for telling whether certain departments are working at their best efficiency or not.

87. Weekly and Monthly Reports.—All the reports which have been mentioned are best submitted weekly under ordinary conditions. In addition to these weekly reports, there will be in any business certain monthly reports. These monthly reports will be kept on hand for reference until the next monthly report is ready. Such a monthly report can be well presented on the same printed form as that shown in Fig. 13. The machine orders are arranged in this case in order of urgency. Comparison of this monthly statement with reports for previous months will show to what extent shipping capacity is taken up.

For summarizing some of the principal reports which have been submitted by the different departments, a general monthly statement is prepared by the private secretary in a works manager's office. The items given in this report indicate the number of machines shipped during the year up to the day of the report, and comparison of this number with the same items, same date, previous year. Fig. 15 shows such a report.

For particular purposes, carefully prepared reports, as above indicated, can be made nearly as effective as the results obtained from a monthly closing of the books. The latter process is, in many businesses, totally out of the question.

88. Discussion of Reports.—To gain any real advantage from reports, however, they must be given attentive consideration, and thoroughly discussed by a council consisting of the heads of all departments affected by the reports. A great many manufacturers realize the advantage of such council meetings, but fail in lacking the initiative of getting such meetings started and keeping them up. These meetings are becoming more and more a feature of successful manufacturing establishments. The meetings are best held at such times when they do not interfere with the lunch hour, or personal time of employees. A morning period from 10 A. M. to not later than 12 has been found the most satisfactory.

89. Graphical Reports.—To many managers graphical summaries of reports present a lifelike picture of conditions in a most comprehensive manner, and suggest remedial steps, where mere tabulated figures would not have been such a stimulus. This is particularly true when the works manager is an engineer, or has had scientific training, and is accustomed to the graphical method of presentation and consequent analysis.

I have known of instances where the most important and radical steps were inspired by reflection over a graphical chart. On the other hand, there are managers who can appreciate only the numerical and tabulated figure method of making charts or reports, and who consider any conversion of numerical records into graphics as needless waste of time. It is well worth while for those who have not used graphical methods to consider that every successful manager makes scientific use of this imagination when his intuition or judgment tells him that certain steps are necessary. If certain helps to guide this intuition or judgment can be gotten from graphical charts which do not require a great deal of time or expense to prepare, then the charts are certainly worth while.

Such a graphic report (Fig. 16), showing graphic comparison of orders received, orders shipped, and orders in production, arranged by classes of product, can be easily prepared.

Similarly, other elements in manufacturing can be visualized. Fig. 17 shows a graphic comparison of labor and material costs with estimated value of product. The lowest line is that representing supervision and clerical labor. This will not vary as much as the other lines; the next line is measured from the line just drawn as a base line, and shows the cost of unskilled labor (the items given are expressed in dollars, and laid off to scale);

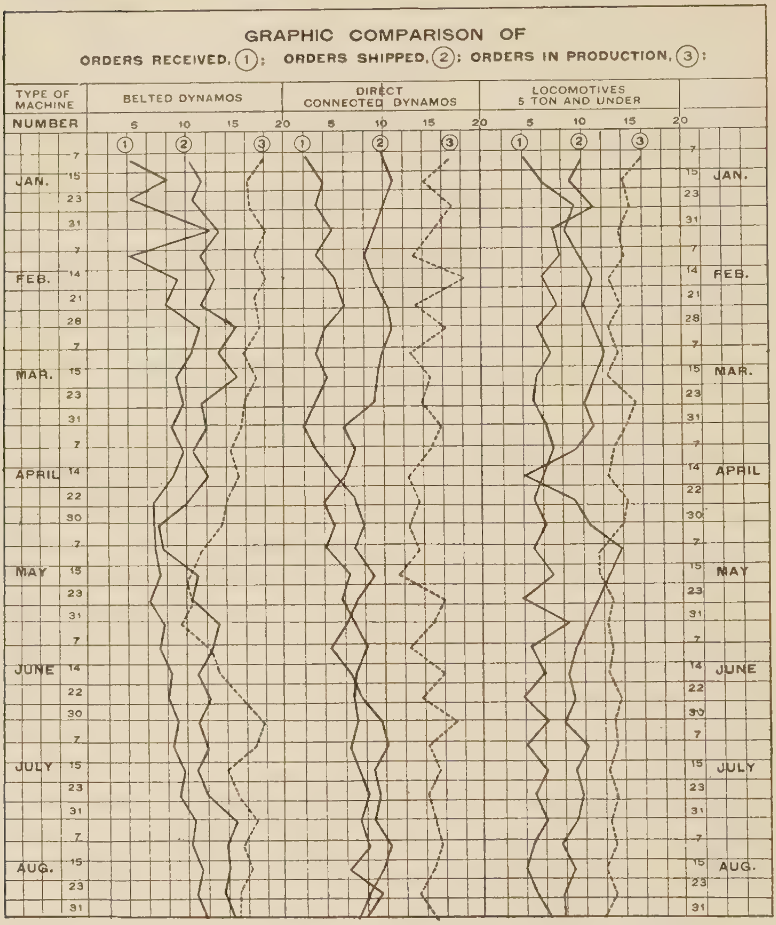


FIG. 16.—For the manager who has learned the value of graphic representation of facts, nothing can compare with a chart as a means of getting at the essence of a mass of figures. The data given in this chart is hypothetical and the quantities taken are arbitrary. The value of the graphical method is well brought out, however, and the arrangement necessary to secure the results here shown is applicable to a great variety of conditions. The relative condition of three of the facts essential to the manager—orders received, orders shipped, and orders in production—is made evident at a glance four times a month throughout the year. Pay-roll periods often make satisfactory intervals by which to plot the condition of production on a chart, but periods suitable to the business must be taken.

while the third line is the cost of skilled labor. Cost of material used in the month's production is graphically presented by line

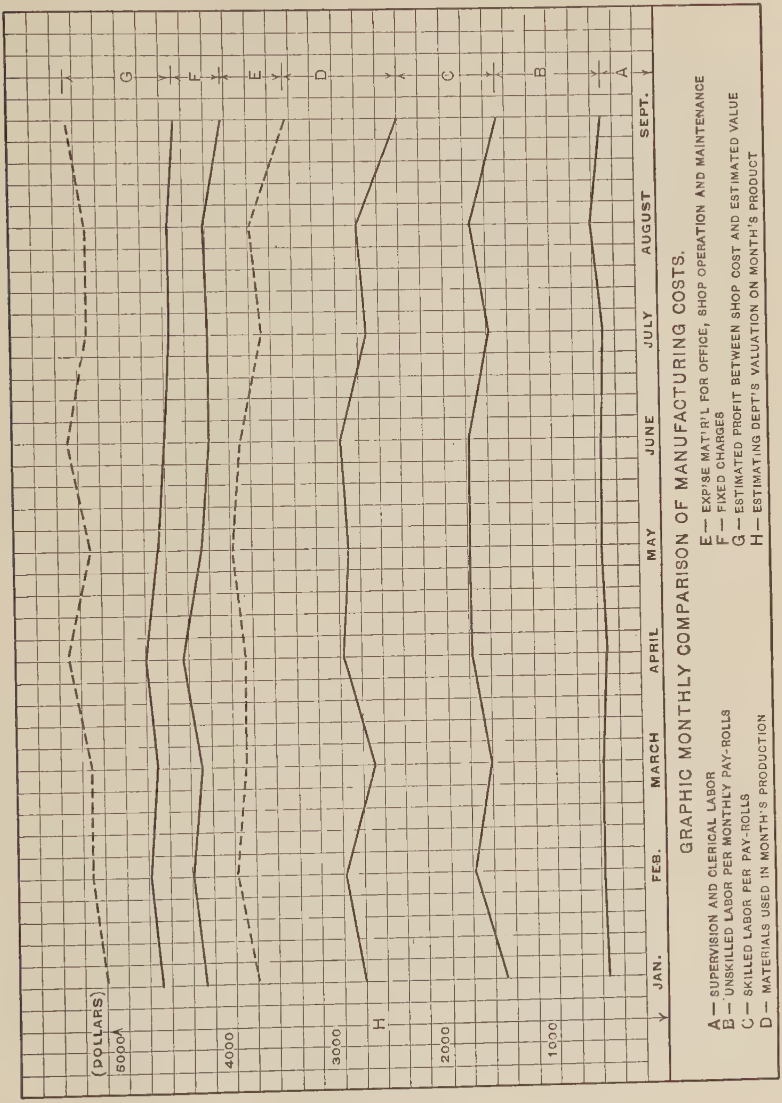


FIG. 17.

four, and the fifth line is the exact cost of "expense" material for the month for office and shop operation and maintenance. The sixth line represents the "fixed charges," including depreciation, interest, and all other shop charges. The seventh or top line is measured from the base line, and represents the estimating department's valuation of the month's product delivered to the sales department, and not including selling expense. This is based largely on established cost values, or "standard costs" of the items produced.

So long as all the area underneath the sixth line does not project above the seventh line there is a likelihood of profit and indications are for efficient production. The reverse is the case when the sixth line projects.

It is well worth while to put one or two experienced cost or production department men at this estimating work. If they are of the right caliber, they will get results not far from accurate without going to extremes in detail, and will be able to present very interesting matter. It is in many manufacturing establishments wholly impracticable to make a general business statement more than once a year. The nature of their business is such that an attempt to close all records and show monthly results is entirely out of the question. Yet the strain of the uncertainty, consequent on a year's wait, can be relieved by estimates and by reports.

Further departmental reports may cover such matters as the following:

90. Quarterly Reports of the Most Important Component Parts.—These should cover the total number of each component ordered to be made during a quarter-year, the total number shipped during the same period, the total number delivered to shop or finished parts stock during the quarter, and a comparison of these data with the same items during the previous quarter-year. This report will serve as a valuable guide in establishing a manufacturing program for stock of leading component parts, a matter which needs to be considered in a comprehensive way, taking into consideration capacity of shop as regards labor and equipment, probable sales, etc., no matter how automatic the routine of reordering for replenishment on the part of stock-record or production department clerks may be.

91. Pay-roll Analysis.—Each pay-roll should be analyzed so as to show the leading classes of indirect labor, and their proportion to direct labor by classes of work and by departments. This requires as a starting point the classification of each workman's daily time record and the assembling of these classifications into pay-roll periods by departments.

92. Money Value of Direct and Indirect Production.—Where there is a complete stores accounting system installed, it is possible to have periodic reports of the money value of the parts turned into stock-room, value of completely assembled product turned into stock (all goods going in to stock previous to shipment), value of work in process by closing of cost records to a certain date, value of additions to plant and equipment made by the shop.

93. Purchases.—Classified report of money value of all purchases during a given period compared with same for corresponding previous periods.

REFERENCES

Carpenter: "Profit-making Management," Chapters III and XIV.
Cook: "Factory Management," Chapters IV and X.

CHAPTER VII

FACTORY LOCATION

94. Importance of Plant Location.—The problem of factory location presents two general aspects: first the selection of a given town or city, and second the location of a factory site in a given town or city. The problem of factory location is one that presents itself to the industrial engineer who is working for the lowest cost of production. Location means everything to the retail establishment, it means less to the factory as a rule; yet its importance is often overlooked. A well-managed factory may fail in a poor location while a poorly managed one often owes its very existence to the location.

95. Considerations Influencing Selection of a Certain Town or City.—The selection of a town or city for a factory site is influenced by considerations regarding: (1) raw material, (2) labor, (3) transportation, (4) market, and (5) money outlay.

96. Influence of Raw Materials.—So far as the cost of raw materials is concerned, that location will be the best which will make total resultant freight charges of all raw materials the minimum.

As a simple example, we may take the case of an establishment manufacturing paving brick. It has been estimated that the relative weights of clay, finished product, and coal required in this industry are approximately as 40, 30 and 3. In a case of this sort it is evident on a brief inspection that in the matter of choice of factory site as between coal fields, clay beds, and nearest market or distributing center, the most advantageous point of location would be next to the clay beds. Of course, the combination of several favorably influencing conditions will be more desirable, such as clay beds with cheap fuel close at hand. Such conditions exist in natural gas fields in several sections of the country.

Similarly the best location for a blast furnace is a site where ore, coke, and limestone may most conveniently be brought together. About two-thirds of the Lake Superior ore is at present melted in the vicinity of Pittsburgh, and most of the remainder in Ohio and Illinois. The reason for this is apparent when one remembers that the total weight of fuel required in furnace work is about 20 per cent. of the weight of the iron produced.

Nearness to coal is to be had in Pennsylvania, Ohio, Indiana, Illinois, Missouri, Iowa, Kansas, Kentucky, Tennessee and Alabama. The Lake Superior region furnishes about two-thirds of all the iron ore in the United States and most of the remainder comes from the Appalachian region, from Maryland southward.

97. Labor Conditions Affecting Selection of Factory Site.—From the standpoint of ease of securing satisfactory labor, the city presents a far more advantageous labor market than a town or country site.

Skilled labor is most easily obtained on short notice in a city. In the country town labor is cheaper, and the workmen are likely to be more contented. They are likely to marry and have homes in pleasant surroundings, and the inducements for the wasting of their earnings are not so great as in the city. At the same time the country factory is looked to as bound to exercise a paternal interest in the employees and town—a responsibility from which the city factory is relieved.

A surburban site, convenient to a belt railway, such as exists in most of the larger trade centers, presents many advantages of both city and country. It permits the purchase of sufficient ground for a factory site to allow for future expansion. It has the labor market of the city to draw from and offers the workmen, who choose to live close at hand, the opportunity of pleasant home sites.

98. Transportation Facilities.—The cost of transportation of both raw material and finished products is a factor of vital importance to the manufacturer who is at the mercy of a single railroad. Where such is the case it has been claimed that it is the tendency of the railroad at first to show a willingness to do everything possible to develop a good trade for the manufacturer, but after the establishment of such a good trade, to tax the traffic all that it will bear. To avoid this contingency it is very desirable that the location be such as to afford a choice of several routes or a choice of railway or water routes in receiving and transmitting shipments. As between railways and water ways, the latter have the advantage of cheapness, whereas the former have the advantage of greater speed.

A factory producing an output of considerable bulk, and which will not suffer from slight moisture, would be advantageously located on a water way. The greater expense of railroad transportation is largely due to the high speed demanded for passenger traffic. A system of freight railways especially arranged for heavy tonnage and moderately slow speeds it is claimed, would be of great advantage to the economic distribution of factory products.

A location convenient to receipt of raw material by way of the cheaper waterways, and at the meeting of railways, makes a most favorable location for a factory site. Examples of manufacturing centers so located are found in Pittsburgh, Buffalo, Cincinnati, Cleveland, Milwaukee, Chicago and St. Louis.

In the case of light machinery, or of any output in which the labor is considerably greater than that of materials, nearness to raw materials is of minor importance, the largest cities are always the best places for the securing of the most skilled labor, and they offer also advantages of promptest shipping facilities for manufactured products, and of a sales market close at hand. Industries of this sort are naturally most numerous in the larger cities of the country, such as New York, Philadelphia, Boston, Chicago, and so on.

It will be apparent that numerous cities much smaller than the examples mentioned, will answer many of the requirements for most economic factory location. While the history of the past seems to point toward the large city as the most favored factory site, there are many examples of success in the smaller towns. The labor agitator finds the small town a poor field. The pleasant surroundings and sunshine of a home tends toward contentment—the worst enemy of the walking delegate.

99. Sales Market as Affecting Plant Location.—As regards the choice of a town or city with reference to the nearness to sales market, it is quite evident that the factory from considerations on this score should be at the point from which it could ship with relatively equal promptness and relative cheapness of expense to each of its principal sales centers. The location of many factories in surroundings not at all favorable to cheapness of production has been due to the fact that their founders, realizing the local demand, started the establishment in the best sales market, and, having usually at the start a limited capital, the local site itself was usually not influenced by considerations of what would be the best site for cheap production, but what would be the cheapest site obtainable in quarters not too unfavorably situated.

The oldest manufacturing establishments of the country have been located chiefly in distributing centers, or cities where business men conveniently meet and commodities may be easily exchanged. In addition to the advantages from a selling standpoint such centers presented the advantage of abundance of labor. The convergence of railroads in larger centers of this sort has also offered facilities for the securing of raw materials and shipping of products.

The advantage of direct contact with the consumer that is offered by a factory in the large city is well worth considering. Frequent instances may be found where, after the removal of a factory which has found its city site disadvantageous as compared with a location in the suburbs or the country, some new-comer has been able to start a thriving establishment near the old site with perhaps less profits but still reaping the advantage of this close touch with the market.

The cities that form the best sales markets are those where trade routes meet or toward which they converge. Similarly good sales markets are afforded by cities at the convergence of navigable rivers, such as Pittsburgh and St. Louis, or at points where the limits in direction of a waterway necessitates trans-shipment, such as Chicago, Cleveland, and Cincinnati.

Another class of cities forming good markets is found in cities which are collecting and distributing points in an exceedingly productive region, such as Indianapolis and Kansas City.

In cases where the factory is not needed as an adjunct to sales department, considerations as to cheapest site, cheapest transportation of raw material and finished product, and good labor markets should be of great importance in determining the location.

100. Cost of Plant as Affected by Site.—The question of money layout is frequently one on which too much stress is layed. It frequently happens that the enterprising citizens of a small town are willing to furnish a free site for a factory. They may even go so far as to raise the cash bonus usually obtained by the sale of building lots in the vicinity of the proposed factory site. Such inducements may often be based upon sound logic and may result in good to all concerned. There have been, however, cases where even with such advantages the factory has failed and the enterprising citizens have lost money they have invested in town lots because insufficient consideration had been given to more important factors. The final decision is only to be made after giving each its proper weight.

Cheapness of factory site has in many cases formed the basis of the possibility of a new company competing with older companies.

101. Branch Factories.—Even the large corporations which have come up by a result of mergers of minor companies have of late years tended toward the establishment of a number of various complete plants located in various centers in place of what seemed to be the original tendency, namely the centralization into a few large plants and the conducting of distinct processes or functions by each plant rather than the making of the same product in more than one plant.

It is possible that the era of combination may be followed by just as rational a period of decentralization. There are too many intermediary agencies that raise the cost of production and distribution to make the centralization and combination of all factories an economic consideration. There is a legitimate most economic territory, and a corresponding maximum capacity for economic production, that points toward distributed production as an ultimate condition, even with centralized capitalization. This tendency is well illustrated by the procedure of the United States Steel Corporation.

102. Railroads as an Aid in Factory Location.—The industrial agents of railways are continually gathering and distributing data regarding favorable sites for prospective industries. In some cases their reports and recommendations indicate careful study, and the obtaining of definite knowledge at first hand. In other instances the data collected are apparently based upon replies to circular letters addressed sometimes to leading merchants or hotel keepers, and sometimes to secretaries of commercial clubs or boards of trade. Where the latter is the case, it is evident that the work done by the industrial agent is purely clerical. The replies sent from various towns along the line are usually from people whose horizon is limited, and who, for the sake of booming their town, will always be willing to make rosy reports. If there happens to be a deserted factory building in the town, the enterprising citizens can see a fine field ahead for the manufacture of almost anything that could be suggested, for the sake of having the old site reoccupied if even for a limited time.

So far as distributive establishments are concerned, local advice is apt to be valuable, but even then, personal knowledge based upon a visit to the town should be added by the industrial agent. On the other hand, information regarding location of productive industries gathered from purely local sources is likely to be erroneous.

The country is, however, full of real opportunities for productive industries. There are no people in better position to make a careful study of the conditions governing them than railway officials. The ability to give reliable advice can be based only upon personal study of natural resources, trade and market facilities, and economic statistics. The pursuit of such studies, and the exercise of sound judgment consequent upon them, requires a knowledge of manufacturing processes and industrial economics in addition to ability of high order.

Census reports and state departmental reports are always more or less retrospective. The true function of the railway industrial agent is to look ahead clearly, making only such cautious use of reports and statistics as a sound judgment dictates.

The problem of selecting a factory site is one which at some time or other is bound to confront practically every manufacturer.

If at such times the manufacturer has made a careful study of the question from all points of view so that when he has to make a purchase of real estate he knows exactly what he needs, he is far less likely to suffer handicap which may result in decrease of profits, or even failure, than if he has not made such a study.

When a business is small, high freight rates on raw material or other disadvantages due to location of the plant are not felt nearly so keenly as they are when the business has been enlarged and must strive for a constantly widening market.

103. Selecting the Site in a Given Town.—Having considered fully the question of the location of the town or city, let us now take up the question of the picking out of the factory site in that town.

At first sight it would seem as though there were hardly any doubt but that a manufacturing establishment, which uses heavy raw material which has to be shipped from some distance, would be best located on a railroad track, and yet if we go through any of our manufacturing cities we find that in many of them probably the majority of such manufacturing establishments are located away fron railroad tracks. The small establishment thrives best near the great buying centers which are usually away from the railroad tracks and it is also nearer a good supply of labor than it would be if located on a railroad track.

104. Local Trade Centers.—There is also often an advantage in being located in a center which is already known as one where certain classes of manufacturing prevail. For instance a clothing shop would likely be manifestly out of place in a center devoted to the manufacture of machine tools and *vice versa.*

105. Local Transportation.—In changing locations in a given city a manufacturer should get positive knowledge concerning the cost of trucking to his various city customers and where there will be extra drayage charges from his local supplier to the new site, also what the drayage or switching charges will be to the various railroads from his new site as compared with the same charge from his present location.

The factory site on a water way without railroad facilities is of little advantage nowadays. On the other hand a location accessible by both water and railroad is particularly desirable. The wonderful manufacturing development in recent years in such cities as Detroit, Cleveland, and Buffalo, is evidence of this. Such a location is especially desirable for industries using bulky raw materials such as timber and iron ore. Since the waterway will serve these raw materials with low transportational charges and a railway is convenient for shipping out finished products, such a site offers especial advantages.

In selecting railroad trackage the particular class of raw material which may be found along the line of a certain railway may decide the question of site in favor of a certain railroad even though outward shipping facilities on that road may not be as good as those of another. For instance, a company making sewer pipe or fire brick might prefer to be located on a road which passes through the fields from which it draws its raw material even though that road might not be as able to handle outgoing shipments as well as another railroad.

106. Local Labor Market.—Nearness to a general labor market may even have to give place to nearness to a specialized labor market. For instance, there is a constantly increasing trend of machine-tool builders toward the Mill Creek Valley settlement of machine-tool shops in Cincinnati. A similar trend of manufacturers of automobiles is toward the favorite driveways of Detroit, whereas both Detroit and Indianapolis are recognized as good

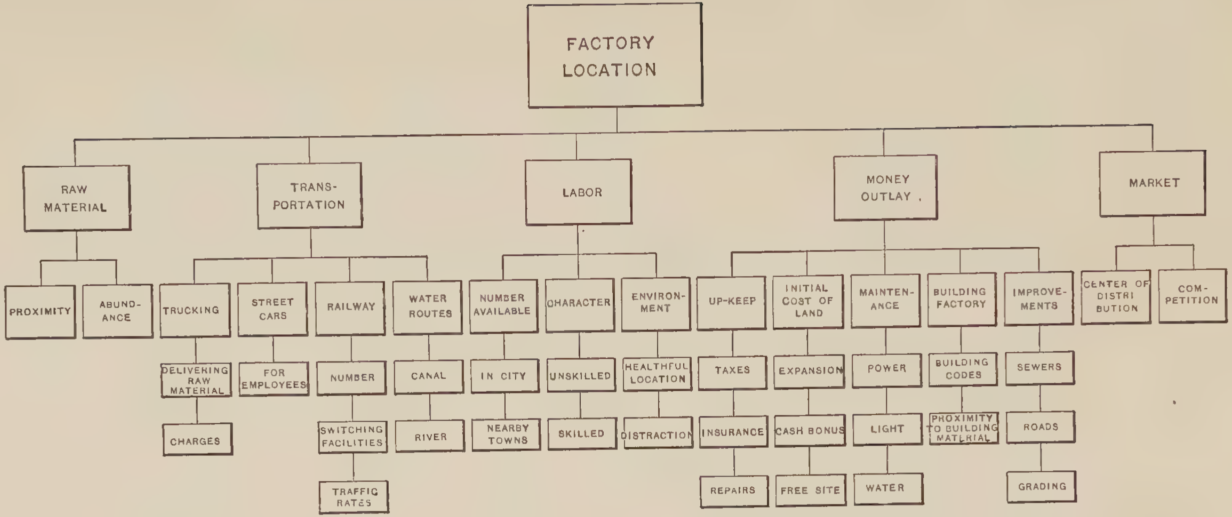


FIG. 18.—Leading considerations in plant location charted by editorial staff of *Factory Magazine* to illustrate article by the author.

labor markets for workers on automobiles and automobile parts. Even in getting into the specialized centers, however, another factor needs to be considered, namely, the nearness to the working man's home. . Other things being equal, the working men will prefer to work in that shop to which they can walk or to which the street-car trip is shortest, hence it is important to find out where the majority of the workers live who are employed in the special industry involved and to locate the new factory near to the working men's homes.

107. Local Sales Centers.—Nearness to the sales center of a city may in many establishments be especially important since personal visits from buyers will thus be encouraged. This is evidenced in many of the jewelry and other small manufacturing businesses in our large cities.

In buying land at the outskirts of a city, the purchaser should assure himself of the adequacy of such factors as are dependent on public service corporations, such as supply of water, light and power, and street railway transportation.

The busy manufacturing plant located where many people will see it, has an advertising value worth many pages of paid space in newspapers and magazines. A number of successful automobile factories have for this very reason been located on roads which are favorite drives.

108. Suburban Sites.—In considering the cheapness of a site in the suburbs or outskirts, attention must be given to such questions as cost of survey, of laying water and sewer lines, of road improvements, of side-walks, of grading and other preliminary work; also the cost of the building operations in a location where all the material and equipment have to be hauled a long way.

The general run of real estate agents do not have available such data as are indicated in the above outline and a manufacturer selecting a site is lucky if he can secure the services of a real estate man who has made a special study of factory sites in his town. Such a specialist is likely to be in much demand and will have little time to waste on promoters, cranks and inventors without any real money to invest.

Fig. 18 summarizes in the form of a chart the leading considerations with regard to Plant Location.

REFERENCES

Day: "Industrial Plants," Chapter III.
Tyrrell: "Engineering of Shops and Factories," Chapter II.

CHAPTER VIII

THE PLANNING OF FACTORY BUILDINGS AND THE INFLUENCE OF DESIGN ON THEIR PRODUCTIVE CAPACITY

109. Process Mapping.—In general the first step in solving the problem of laying out a complete factory plan, or an addition to an existing plan consists of the determination of the general processes required to produce the various products of the establishment, and indicating the paths followed by the product in passing from process to process. The best way to begin is to take an existing plant making the product under consideration, or one nearly like it. Take one class of product if there are various classes, or one component if there are various components. Draw a phantom perspective sketch of the building or build a small skeleton framework of the building, putting in the floors but omitting the walls (see Fig. 19). If the phantom drawing on paper is used, take colored crayons, letting a certain color of crayon represent a certain product or component, and follow the product or component from process to process, from department to department, and from floor to floor of the existing factory. Use a separate color of colored crayon for each separate principal product or principal component and trace the processing for each in the same way. If the small wooden frame model has been used, colored threads can be used in place of the colored crayon lines.

110. Routing.—Routing is a more detailed form of process mapping, and consists of the listing of every process on a component part. A general route map is usually prepared for the various groups and sub-groups which go to make up a machine or other compositive product, and a route-list is then prepared for each component part. Thus the distinction between process mapping and routing may be shown by stating that in process mapping, departments would be the limit of differentiation; in routing, on the other hand, we would assign work to specific machines. A still further differentiation is designated by the

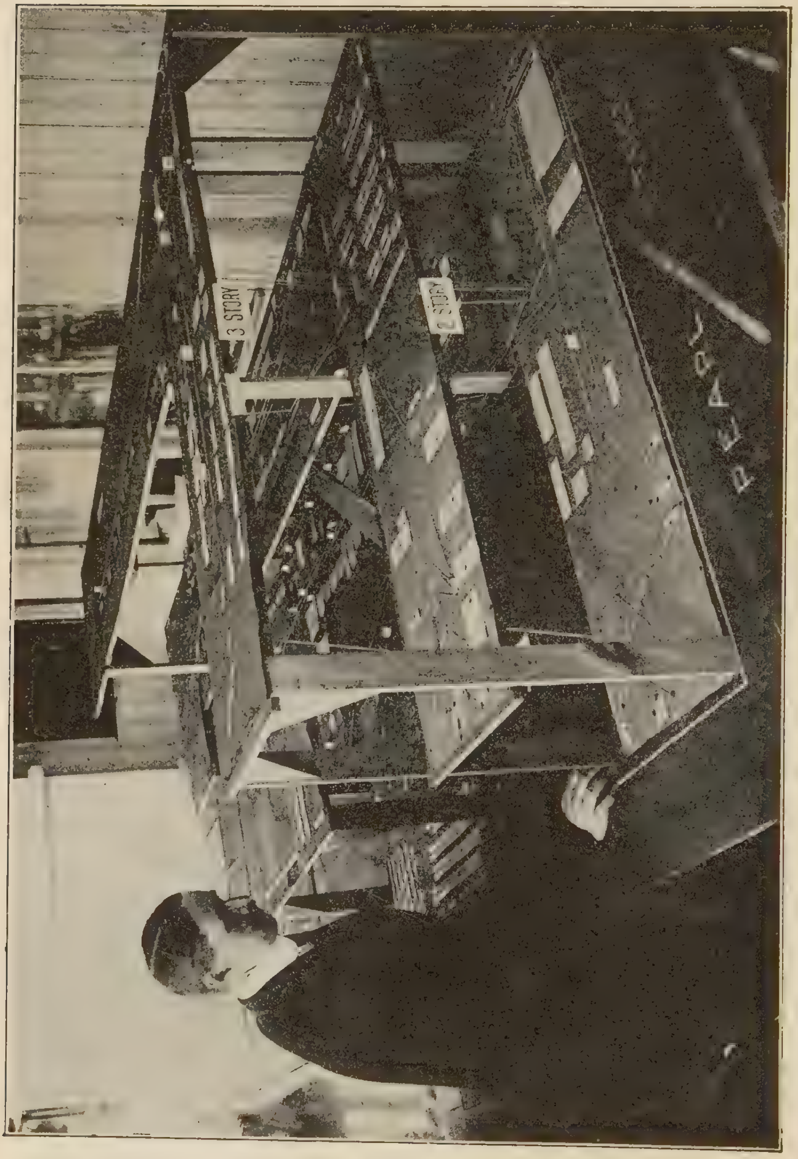


FIG. 19.—Routing visualized by small building model with templets of machines and threads of different colors representing courses of progress.

items on the detailed instruction card or instruction list, which lists each distinct step under the heading of lathe work, etc. The making of detailed instruction lists is more fully discussed in a later chapter. This minute subdivision of processes is not considered in connection with factory planning, but process mapping and routing play an important part in the layout of buildings and departments.

111. Processing Equipment.—Knowing the approximate manufacturing program or year's output, it becomes necessary to determine the equipment required for the production of a given quantity of output. It is evident that this investigation requires at least a general knowledge of the time standards of the various processes.

As an example of the methods to be pursued in estimating equipment required let us take the case of the manufacture of a line of side-crank steam engines, and determine machine-tool equipment required for machining the crank shafts:

Size engine	No. of engines of this size to be built in a year	Lathe operations and time for one			Total lathe time for one engine	Total lathe time on crank shafts
		Center and face	Rgh. turn	Fin. turn		
		H. M.	H.M.	H.M.	H.M.	H.M.
7 & 8×10	100	.20	.40	50	1.50	108–20
9×14	20	.25	.45	1.00	2.10	42–20
10 & 11×16	20	.25	.45	1.00	2.10	42–20
12 & 13×18	20	.40	1.00	1.30	3.10	62–20
14 & 15×20	10	.40	1.00	1.30	3.10	31–10
16 & 17×22	10	1.00	1.30	1.45	4.15	42–30
18 & 19×24	5	1.15	1.30	2.00	5.15	26–15
20 & 22×27	5	1.30	2.00	2.45	6.15	31–15
24 & 26×30	5	2.00	2.30	3.30	8.00	40–00
Total lathe time on crank shafts......			......	......	....	426.30

From the above estimate of the time required to do the lathe work on a crank shaft for the entire line of engines, it will be seen that there is 426 hours and 30 minutes of estimated lathe time on the crank shafts. Experiments made by the Lodge & Shipley Machine Tool Company with an electric recorder wired to a contact piece on the belt shifters on all of their lathes showed that their lathes were running about 50 per cent. of the time.

By constant attention for a period of six months they were able to increase this period to 75 per cent., which probably represents as good an attainment as is possible. In most shops the lathe may be estimated as running not over one-half of the time so that for the purpose of estimating the time that a lathe will be engaged with a given class of work we must double the actual estimated time of doing the work. Hence, we should say that the crank shafts would require two times 426 hours and 30 minutes or 853 hours of lathe-department time.

The immediate conclusion is that one lathe will be ample equipment to do the work on crank shafts and that it can also be used for work on some other parts.

The above example is given to indicate the process of estimating machine-tool time followed in going into detail. In order to be accurate one should, of course, have complete bills of material covering all the machines proposed to be built, also a complete estimate of all operations on all parts. This it will be seen is entirely out of the question as the method to be pursued in preliminary work, as such estimating for a line of engines alone would require the constant time of an expert for a number of months. One can, however, make such generalized investigations as will tend to put him on the safe side in providing sufficient machinery.

Frequently data are gathered on the equipment for a given quantity of output necessary in the existing plant or in other plants making a similar product, such data serving as a guide or check on the adequacy of the equipment for the proposed new plant or extension.

112. Arrangement of Equipment.—Having determined on the processing equipment, according to the methods above indicated, this equipment must then be arranged in the most advantageous manner so as to secure the least unnecessary traveling and handling of materials, so as to secure the allowing of abundant space for storing of rough materials and partially finished product around the machinery and so as to leave ample passage for trucks, industrial railways, cranes, or other methods of transportation. Sufficient room must be allowed to provide convenient access to all parts of a machine, and for the removal of any machine when necessary.

It has been agreed that the floor space in the main shop is too valuable to use as storage space. At the same time there must be sufficient work in sight that the employees may see that they are not "working themselves out of a job."

Having determined on the equipment required in a given department the best procedure is to cut paper templets to scale to represent each item of equipment and secure final arrangement by pinning these templets into various trial positions until the best possible arrangement has been secured.

113. Floor Space Occupied by Equipment.—In order that the templets may be of proper size it is necessary to know the approximate floor space of the various kinds of equipment required. Data of this sort may be obtained by writing to the manufacturers of the equipment in question. As an example of the kind of data to be obtained, the following tables of floor spaces are given:

FLOOR SPACE OCCUPIED BY LATHES

Lodge & Shipley Machine Tool Company, Cincinnati, Ohio

Swing	Space occupied
14 in.	37 in.×11 ft. 3/4 in.
16 in.	44 1/2 in.×11 ft. 3 3/4 in.
18 in.	50 in.×11 ft. 6 3/8 in.
20 in.	50 in.×11 ft. 6 in.
22 in.	57 1/2 in.×11 ft. 5 in.
24 in.	59 in.×11 ft. 4 1/2 in.
27 in.	64 in.×11 ft. 4 in.
30 in.	67 1/2 in.× 13 ft. 11 1/4 in.
36 in.	67 1/2 in.×13 ft. 11 1/4 in.
42 in.	78 in.×15 ft. 1 in.
48 in.	78 in.×15 ft. 1 in.

FLOOR SPACE OCCUPIED BY RADIAL DRILLS

Bickford Drill & Tool Company, Cincinnati, Ohio

Size of working surface	Floor space required
No. 1, 2 1/2 ft.×3 ft.	90 in.× 97 in.
No. 2, 2 1/2 ft.×3 1/2 ft.	90 in.×109 in.
No. 3, 2 1/2 ft.×4 ft.	90 in.×121 in.

FLOOR SPACE OCCUPIED BY MILLING MACHINES

Cincinnati Milling Machine Company, Cincinnati, Ohio

Horizontal Millers

Working surface	Floor space
No. 2, 11in×7 1/4 in.	77 3/4 in.×92 in.
No. 3, 13 1/2 in.×55 3/4 in.	83 in.×106 1/2 in.
No. 4, 16 1/2 in.×64 1/4 in.	97 in.×125 1/2 in.
No. 6, 19 in.×76 1/2 in.	105 in.×145 1/2 in.

Vertical Millers

Working surface	Floor space
No. 2, 11 in. × 7 1/4 in.	84 in. × 89 in.
No. 3, 13 1/2 in. × 55 3/4 in.	89 1/2 in. × 103 1/2 in.
No. 4, 16 1/2 in. × 64 1/4 in.	100 in. × 125 1/2 in.

FLOOR SPACE OCCUPIED BY UPRIGHT DRILLS

Cincinnati Machine Tool Company, Cincinnati, Ohio

Swing	Floor space required
21 in.	18 in. × 48 in.
24 in.	21 1/2 in. × 58 in.
28 in.	24 in. × 67 in.
32 in.	26 in. × 71 in.
36 in.	28 3/4 in. × 79 in.
42 in.	30 in. × 90 in.

FLOOR SPACE OCCUPIED BY PLANERS

American Tool Works Company, Cincinnati, Ohio

22 in. × 5 ft. planer	4 ft. 8 in. wide by 12 ft. long
24 in. × 6 ft. planer	4 ft. wide by 14 ft. long
26 in. × 6 ft. planer	5 ft. 2 in. wide by 14 ft. long
28 in. × 6 ft. planer	5 ft. 4 in. wide by 14 ft. long
30 in. × 8 ft. planer	5 ft. 8 in. wide by 18 ft. 8 in. long
33 in. × 8 ft. planer	5 ft. 11 in. wide by 18 ft. 8 in. long
36 in. × 8 ft. planer	8 ft. wide by 19 ft. 4 in. long

FLOOR SPACE OCCUPIED BY SHAPERS

Cincinnati Tool Works Company, Cincinnati, Ohio

15 in. shaper	60 in. wide by 42 in. long
16 in. shaper	66 in. wide by 43 in. long
18 in. shaper	72 in. wide by 46 in. long
21 in. shaper	82 in. wide by 53 in. long
25 in. shaper	90 in. wide by 54 in. long
30 in. shaper	98 in. wide by 60 in. long

114. Arrangement of Departments.—After having determined on the equipment and its arrangement in each department, the lay-out of each department being prepared separately first, the next step is the arrangement of the departments and their surrounding buildings with respect to each other.

It is not advisable to consider proportion, dimensions, or location of various departments until one has determined for each department its equipment, space required for same, storage space, and passage areas. It is desirable in this connection to investigate data covering actual equipment in use in shops making the same or similar product to that contemplated and to reduce these data to such units as floor space per unit of output and floor space per employee.

It must be evident that a wide variety of output cannot be advantageously built in a single shop. It sometimes happens in the machine-manufacturing business that a single shop must, on account of trade conditions, manufacture both light and heavy machinery, or machinery and light detail fittings. In such cases careful planning of departmental arrangements, equipment, and organization is particularly necessary, so as to keep the separate costs of production of each type distinct, and at a price reasonably near the minimum for each class. Again, it has been found that the building of groups of parts representing a complete organ of a machine, in a single department, is often more likely to bring about more economic production than an arrangement in which all pieces travel through the whole shop in which each distinct class of machine tools is grouped by itself.

115. Consecutive and Simultaneous Processes.—The route charts for the various kinds of product will indicate that certain groups must arrive at a state of completion simultaneously. The departments and buildings must be arranged so as to adapt themselves to the equipment and flow of work, following always the lines of least resistance as regards not only losses in transmission apparatus but losses in activity of working men. The proper arrangement of departments and of machines with regard to each other depends upon statistical knowledge of the most predominant paths of travel of the material in process of manufacture. Such observational information alone can determine to best advantage also the location respectively of rooms for stores, stock, tools, grinding, etc. Where a number of simultaneous machine-tool operations must terminate in a central assembling or erecting department it may be desirable to have two or more buildings running east and west, for example, containing the preliminary simultaneous operations, these buildings terminating in a single north and south building in which the assembling and erecting are done.

116. Use of Templets in Arranging Departments.—Having determined in the foregoing manner the general dimensions of the various departments, and given due consideration to departmentalization by processes as against departmentalization by product, as well as to simultaneous and consecutive processes, templets should be prepared showing the general proportions of each department, and these templets shifted around until the most desirable arrangement of departments with reference to each other is secured.

117. Service Departments.—The process-maps and route-charts will be found valuable guides in determining to best advantage the location of the so-called "service" departments, such as rooms for stores of raw material, stocks of finished parts, tools, blue-prints, grinding, lavatories, etc.

Lockers and wash-rooms should be so planned that thorough discipline and system can be maintained with regard to them. Good discipline and system in these incidental features is bound to react on the work of the shop as a whole. Workmen should register time after depositing clothes, etc., in lockers, and not before, and location of lockers and time-clocks should favor this method.

118. Visibility of Work and Economy of Transport.—Outside of the locker and wash-rooms, the only portions of the shop which it is desirable to have partitioned off and not subject to visibility are such departments as need isolation on account of the work to be carried on in them by reason of gases, smoke, dust, or similar objectionable features. The requirements of modern factory regulations, however, usually specify exhaust systems for removal of all of these objectionable gases, smokes, dusts, etc., so that a forge-shop or grinding department may be seen in modern factories under the same roof as the machine shop and without any separating wall or partition.

It is important that as much floor space as possible should be visible at all times. Hence all "L's", "E's" and "H's" should be avoided in favor of the plain rectangle with all departments under one roof.

Economy of transport demands a minimum of passage ways. Passage ways encourage aimless wandering and loitering.

119. Single-floor or Multi-floor Building.—Considerations of visibility and the avoidance of unnecessary walking or elevator-riding, argue for the single-floored structure as against multi-floored buildings. Even the single gallery in monitor-roof buildings is best avoided, as it forms a more or less isolated set of areas not readily visible, and increases walking, stair-climbing, elevator-riding, and trucking.

The questions as to whether the fixed charges due to increased cost of building and land will not be in excess of the economies due to visibility and economy of transport, must be given due consideration. The cheapest type of building calculated on the basis of fixed charges per square foot of floor area, is a three-story building 40 to 50 ft. wide and 100 to 120 ft. long. As a general rule for medium heavy and heavy work, the single-floored building will show up favorably even where land is costly. The lesser fire-risk and greater productivity per unit of floor area must be set off against the interest and other fixed charges per unit of floor area. Moreover a large tract of valuable land is bound to rise in value, and would mean a greater value of real estate in time, though it might also mean higher taxes. The fixed charges should be calculated for the various proposed sites and types of buildings and compared with estimates of comparative economies or losses in productivity.

120. Allowing for Future Expansion.—The site selected, as well as the shape of the building, must be such as to allow for expansion. This demands the possession of land enough to allow for the extension lengthwise of a building and such lateral expansion in the way of increased width of single buildings or additional buildings as may in time be needed. One way of securing ease of expansion is to have at hand a plan for buildings to house double, triple, or quadruple the production at present planned for, and make the present plans in such a manner that the future plans can be easily worked out.

A well-designed building will provide facility of enlargement, maintaining the same balance of floor area. This demands the recording of all increases of departmental area whenever they have become necessary, and the use of such records in preparing the designs for new buildings. It has been aptly stated that a well-designed factory building or set of buildings should be as flexible and adaptable to enlargement as the "unit" system of filing cabinets. Fig. 20 shows the rear view of the factory of Ludwig Loewe at Wittenau, near Berlin. It will be noted that either the saw-tooth shop or either of the lateral buildings may be extended toward the rear, preserving the same balance of area.

121. Service Equipment.—By service equipment is generally understood all machinery and apparatus necessary for running the factory and not constituting processing machinery. Under the heading of service equipment would come such apparatus as heating and ventilating appliances, lighting apparatus, fire prevention equipment, water supply, sewage system, mechanical transportation, power generation and transmission.

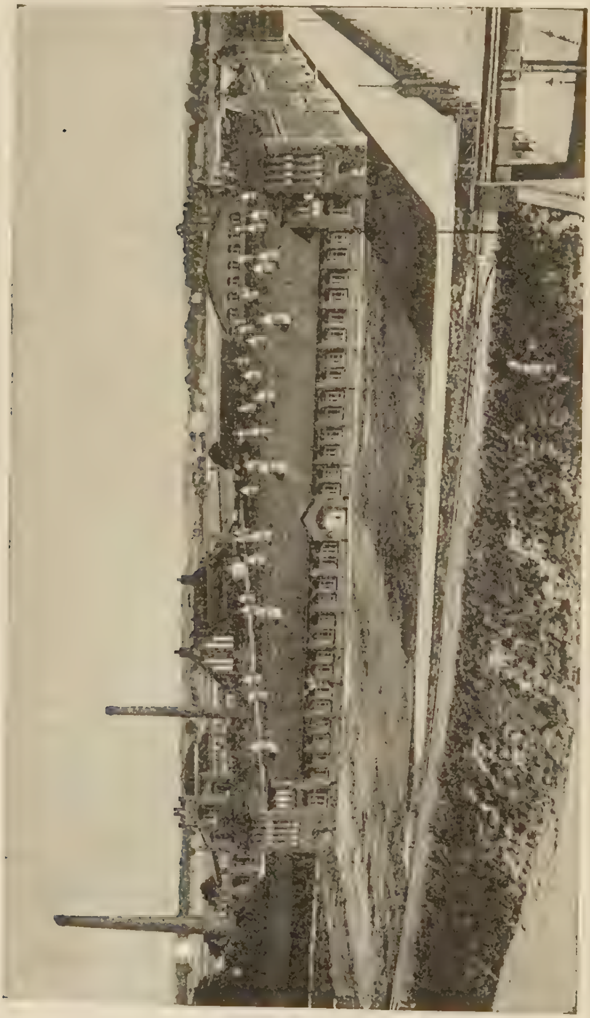


Fig. 20.—Rear view of the factory of Ludwig Loewe, Wittenau, near Berlin, showing saw-tooth roof arrangement of main shops with administration front and three-story side structures.

122. Heating and Ventilating Apparatus.—With regard to heating and ventilating, it can safely be said that the loss in labor efficiency and consequent output per man due to faulty installations will certainly be found to be enormously greater than the cost of proper heating and ventilating facilities.

The heating of most factory buildings is best accomplished by the indirect pressure system, using the exhaust steam of one or more non-condensing engines as complete or auxiliary heating medium. Fig. 21 is a view of the shops of the United Railway Company, Baltimore, Md., showing hot-blast heating apparatus and exposed distributing ducts. A more pleasing interior finish can be secured by concealing ducts under floors and in walls. This may involve the use of rectangular ducts, and alterations in length of the ducts as they would be used if exposed, and such alterations must be designed by competent engineers.

In many cases the heating system has been very carelessly put up, without any plans or specifications having been prepared for it. As a result, heating is often insufficient or poorly balanced, and circulation defective. A system of heating should always be planned by a competent engineer. Owing to the very long pipe lines necessary in factory buildings of the modern type, direct radiation systems for factories, even when designed in the best possible manner, are likely to have poor circulation and to be slow in action in cold days unless a vacuum system of circulation is used. The hot-blast system of heating the air in heating chambers supplied with steam coils, and delivering it under pressure from a blower, possesses the advantage of heating a shop quickly in the morning, and of uniformly distributing the heat, if it is properly designed and installed, so that, although the total heat units required to heat the air will be theoretically greater than with direct radiation, the tremendous gain derived from uniformity of temperature and comfortable workers will far more than counterbalance the additional cost of operation when using the indirect pressure system, as compared with direct radiation. The pressure is always outward, hence there is a freedom of drafts and, when properly installed, an avoidance of the accumulation of the total heat radiated at the top of the building, as is so apt to be the case with the direct radiation system. The cubical contents of most factory buildings are so large that sufficient number of changes of air per hour are secured by drawing only a portion of the air for circulation from out of doors, so that the expense of the indirect pressure system when applied to factories can be made a good deal less than that of the same system as applied to public buildings, where the cubic space per person is many times less and the number of changes per hour must be much more frequent. Of course, if the air in the shop is vitiated by the processes of manufacture going on, the foregoing remarks will not apply. It will always prove economical to provide pure air. This is especially true of a factory located in unsanitary surroundings, in which circumstances it will be profitable to provide air shafts of considerable height to draw in pure air or provide other means of purification.

Clean air as a money saver in mercantile establishments and offices has not received the attention it deserves. One can daily see on display, in the show windows of high-grade dry goods establishments, fabrics and gowns worth thousands of dollars, which are being badly damaged by sooty and dirty air.

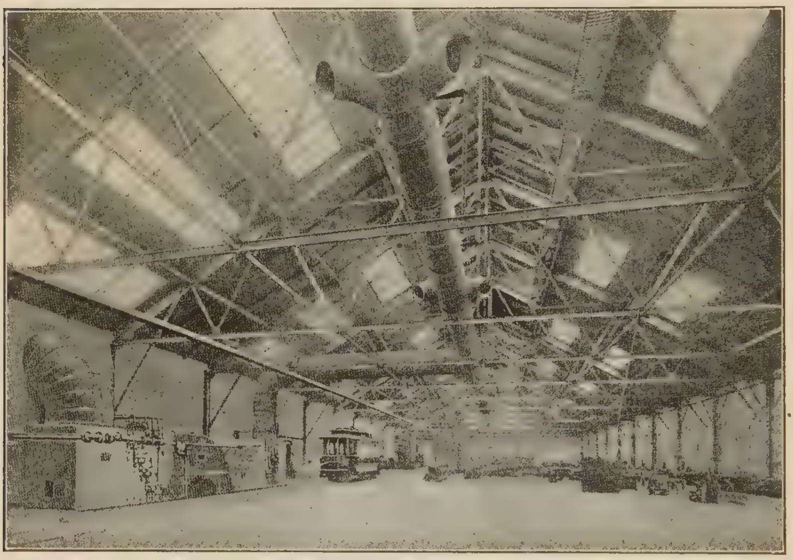


FIG. 21.—Hot-blast heating system as applied to shops of United Railway Co., Baltimore, Md.

The same conditions prevail, to a greater or less extent, throughout these establishments. The depreciation due to dirty air could be reduced 90 per cent. by the introduction of air-cleaning devices whose cost is trivial compared with losses now taking place.

Most engineers and writers on heating have confined their attention, in the matter of the use of the pressure system, to calculations as to how to provide sufficient heat to overcome the heat losses through walls, windows, roofs, floors and open doors, and have apparently failed to appreciate the importance of furnishing better health and greater activity of employees from breathing wholesome air, which always results when the pressure system is properly installed.

In a building thus ventilated there need be no drafts, as the most healthful conditions are reached by keeping all windows tightly sealed. The outlet of air is best secured by a separate set of ducts leading to the roof.

This system is so common that it seems almost impertinent to mention it. Nevertheless it is equally common to see great black streaks radiating from the hot-air ducts, showing how full of soot and dust the air is which is forced into the building, though it is otherwise full of oxygen and far more healthful than the air furnished by any other system of heating and ventilating.

The black streak, however, is entirely unnecessary, and can be absolutely avoided by proper systems of air washing—a process accomplished by either of two systems of spraying; the first method is used where only a moderate water supply is available; the second, where abundant water is at hand.

The first plan, for cases where it is necessary to be economical of water, is that of using a "coke" washer. In this system the air is drawn through a series of cages filled with coke, over which fine streams of water trickle. The coke absorbs the soot and dust, and will serve in this way without replenishment for at least a year.

Fig. 22 shows a typical hot-blast heater with coke air washer.

The second and better plan is that used where an abundance of water is available. This plan consists of blowing the air through several curtains of fine streams of water. The drying is effected by passing the air alternately over and under a series of baffle plates. The centrifugal force, where the air makes the sharp turns about the edges of the baffle plates, separates the moisture so that the air can be furnished at any degree of humidity desired.

In order that there may be no discomfort with sealed windows in summer, the air can be passed over refrigerator coils, making it possible to secure any degree of coldness.

Another advantage, from the standpoint of economy as well as of health, accompanies the use of air-washing systems, namely, the ability to humidify the air to any desired degree. The normal degree of humidity of the human body is between 60 and 70 per cent. and with this degree of humidity the body is just as comfortably warm at 65° F. temperature as it is at 70° with a low condition of humidity, say 15 to 20 per cent., which is the usual condition of artificially heated atmosphere where the air is not humidified.

This means that a fuel saving of 7 or 8 per cent. can be effected by furnishing air of lower temperature but of higher humidity. It should also be borne in mind that it is seriously detrimental to health to breathe air having so low a degree of humidity as is furnished by most heating systems. The result is an excessive evaporation from the membranes of the body, which is productive of catarrhal diseases. In addition, one is more apt to contract a cold when passing from an atmosphere of 15° relative humidity and 70° F. temperature into outside zero weather with 70° F. of humidity than if the normal percentage of moisture had been maintained within the building.

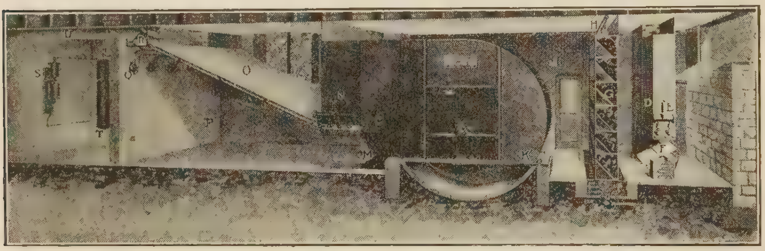


Fig. 22.—Hot-blast heater with coke air washer: C, screen through which outside air enters; D, tempering coil fed by steam pipe E; F, by-pass so air can go through without touching tempering coils; G, coke air filters moistened by perforated water pipe H; I, catch basin; K, blower; O, partition permitting part of the air to be blown over heater coils and part or all to be blown through ducts without passing over heater coils.

Humidity control is effected through the agency of a thermostat. This is possible because of the discovery that the amount of moisture which a body of air will absorb during any given length of time in contact with water is more dependent on the temperature of the water than on the temperature of the air. Hence, when the thermostat indicates that the temperature of the air surrounding it is changing, it follows that the absolute humidity must be changed in order to preserve the relative humidity at a constant percentage. The temperature of the spray water is therefore changed by a steam jet, acting through a device similar to an injector, over which the thermostatic motor has control. Another duty which the spray system of air cleaning accomplishes very efficiently is that of cooling the ventilating air in summer. The entering air is placed in contact with an immense amount of cooling surface, namely, the total area of the water globular surface. The air can thus be cooled by about 80 per cent. of the initial temperature difference between the spray water and the entering air. In order to use the same water a second time, ice must be placed in the settling tank, or such tank provided with brine coils connecting with a small refrigerating machine, to keep down the temperature.

123. Lighting Apparatus.—Abundance of light is as important as abundance of pure air. Natural light should permeate the whole shop during all hours at which it prevails out of doors, and not only work-benches and machines, but stairways and all passages, should be light. The saw-tooth roof, with glass portion toward the north, gives the most agreeable and diffused light. It should be borne in mind that with saw-tooth roof construction, the side windows in the walls can be dispensed with altogether, although this practice is by no means common. To determine how far inward good light will penetrate, a very close approximation can be secured by taking a 45° triangle and laying the hypothenuse along the extreme edges of the glass in either side windows or saw-tooth roof windows. In shops of ordinary height, this will limit the well-lighted area to a distance of from 20 to 25 ft. from the windows, and will limit the width of the saw-tooth "bays" to about the same, unless unusually high windows are introduced or prismatic glass is put into the upper window sashes.

Fig. 23 shows some structural details of the saw-tooth roof construction used in the shops of the Blake & Johnson Co., Waterville, Conn. An interior of this same shop is shown in Fig. 24, showing how well the light is distributed.

Skylights are generally undesirable on account of their admitting so much direct sunlight, and also on account of their liability to breakage of glass and obstruction by snow. In the case of the saw-tooth roof, facing the north, clear window glass may be used, since it is never exposed to the direct rays of the sun. Windows in the ventilating portion of the central roof gable will

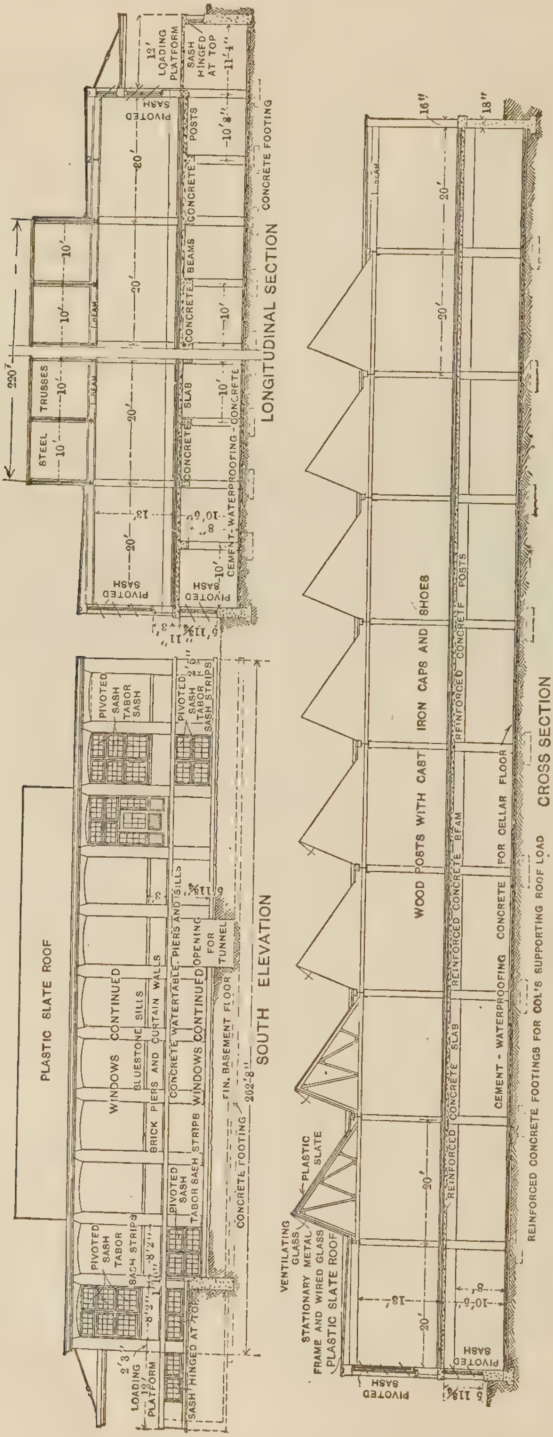


FIG. 23.—Some structural details of Blake & Johnson factory, Waterville, Conn., showing saw-tooth roof shop construction.

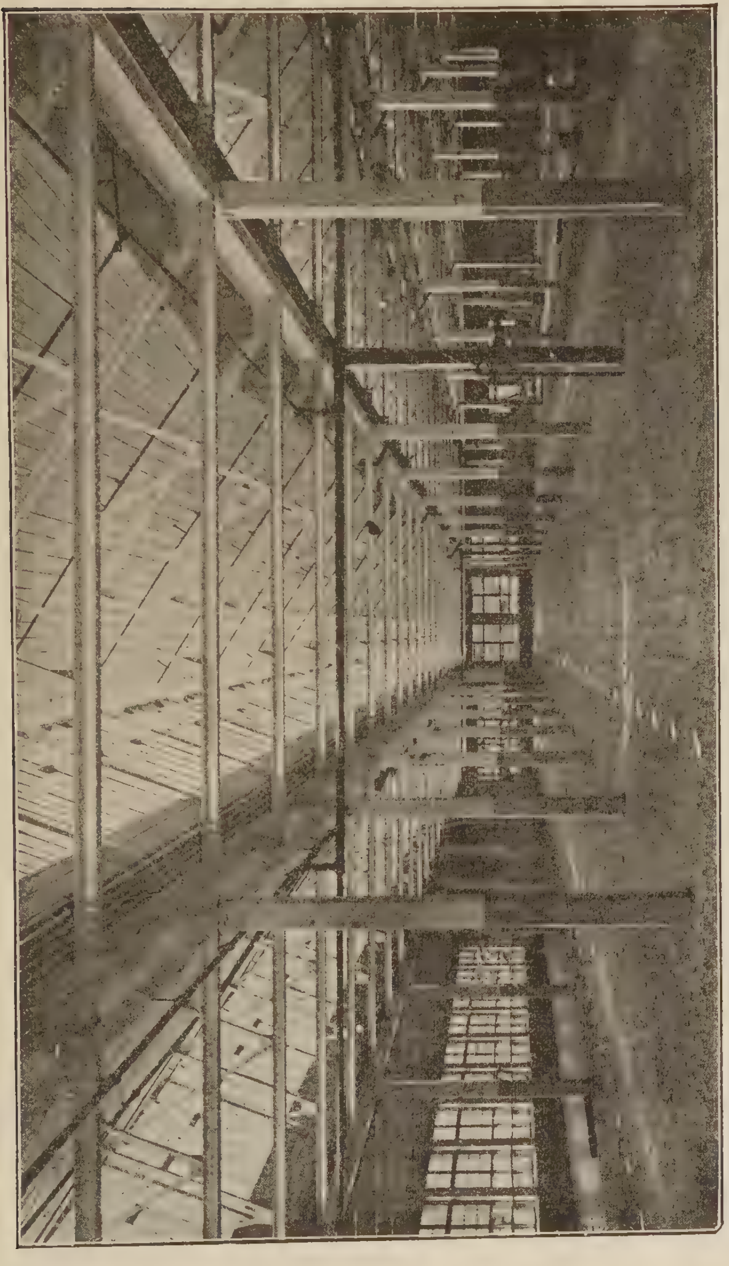


FIG. 24.—Interior of shop of Blake & Johnson Co., Waterville, Conn., showing light distribution in a typical saw-tooth roof shop.

need shades, unless made of ground or yellow glass. As to the side windows, except those facing the north, they are exposed to direct sunlight if there are no closely adjacent buildings. Shades usually receive rough treatment in a shop, and are certainly shortlived, hence opaquing the glass is usually preferred to installing shades. If the nature of the work is clean enough to permit their use, buff color is recommended, since this variety does not shut out too much light. Ground or cathedral glass panes may be desirable in certain locations where it is advisable to keep out direct sunlight or to obstruct the view inward or outward.

Prismatic glass has been used to advantage in places where the light requires to be deflected inward into the space desired to be lighted, as in basements, or in a space darkened by neighboring walls or in top floors with little or no side-lights, but receiving light from sloping skylights. A ribbed pressed glass acting somewhat like a prism may be found to answer in some cases where the more expensive plate-glass prisms might be considered too costly.

As to artificial light, there is but one kind to be considered in a modern establishment having its own power plant, and that is the electric light. In some cases where the factory generates its own gas it may be found that a carbureted producer-gas will be more economical than electric light, even with prompt renewal of Welsbach type of mantles.

As wide fluctuations in the loads of electric generators are accompanied by low efficiencies, it will sometimes be advisable to have a distinct engine and dynamo for lighting purposes. Arc lamps on the incandescent circuit are desirable for general illumination, supplemented by incandescents for individual machines and benches. For monitor roofs where lights must be high above the floor to afford free space for crane service, the flaming arcs will be found advantageous. The mercury vapor lamps are less expensive to operate than the flaming arcs, but proportionally less satisfactory owing to the weird color effects accompanying their use. It may be found desirable to alternate them with flaming arcs to secure sufficient white light. Good light demands that the wiring be of ample size to prevent drop enough in voltage to produce any dulling of incandescent lamps. Wire guards should not be used on lamps excepting where really needed. Their cost and interference with light renders it doubtful whether they are any real saving. For delicate work, the so-called "tipless" incandescent lamp provides the most perfect illumination, being free from the circles of darkness that are cast by lamps sealed at the bulb end. Some provision must of course be made for artificial illumination when the power plant is shut down, by connection to a public electric or gas circuit, or, if this is not available, by a stock of oil lamps for emergency use.

Eye-strain causes brain fatigue and materially deteriorates manual efficiency. Hence careful consideration needs to be given to daylight and artificial lighting. The efficiency of any lighting system depends, not on the number of lights supplied, but upon the extent to which this system enables the eyes to perform their duties with least effort and strain.

With good daylight, all parts of a machine are about equally illuminated. At night, however, with the commonly prevailing system of localized lights, the illumination of machines is very uneven, one part being very highly illuminated and other parts being in comparative darkness. With suitable diffusion, direction and intensity of light, operators can see their work far better with a low foot-candle value of illumination than they can with the high foot-candle values of concentrated illumination.

The eye adapts itself to artificial illumination in such a way that the intensity of light required for good vision at night is only a small fraction of the intensity of average daylight. As a rule, the general illumination of a shop at night is wholly neglected. In order to read ordinary writing, a minimum illumination of about one foot-candle is required. A good reading light should be about two foot-candles. In most shops, the general illumination falls below this. A good indoor daylight illumination needs to be only about forty foot-candles, although this may be considerably increased or decreased without discomfort. Where the daylight is insufficiently diffused, prismatic glass should be used.

With a highly concentrated artificial light and a dark field just outside this concentrated area, conditions are such as invariably result in eye-strain. Continued subjection of the eyes to this kind of illumination results in decrease of vision until the workman is unable to perform his work with accuracy or rapidity. A strong objection to the use of concentrated lights is the glare due to reflection of the bright image of the light, which is thrown into the eye of the operator.

The general illumination of a shop should not be so inefficient as to make it appear gloomy. A low degree of general illumination makes it impossible for the foremen to exercise the same degree of supervision at night as in the daytime.

The remedy for many of these objectionable features lies in the introduction of suitable illumination, proper care of lamps, reduction of the intrinsic light sources, and improved diffusion and direction of light.

124. Fire Prevention.—Too much stress cannot be laid on the great importance of the absolute fireproofing of such parts of buildings as are intended for the reception of the almost unreplaceable requisites of manufacturing, such as drawings, patterns, and inventory. Drawings and patterns of tools, jigs, etc., are too often carelessly treated, since there may be but one article completed from them, but their loss in case of destruction of the tools by fire would be enormous. Consultation of the publications of the National Underwriter's Association, the Factory Mutual Fire Insurance Association, various well-known insurance companies, and the building codes of the various states will be of great aid in settling questions connected with the installation of adequate fire prevention equipment, including such matters as automatic sprinklers, fire pumps, fire hose attachments indoors and outdoors, fire walls, fire doors, etc.

125. Water Supply.—It is important that ample drinking water be available, distributed to sanitary drinking fountains within easy reach of all employees. If there is any question as to the healthfulness of the general water supply of the factory a separate system of healthful drinking water should be installed. Small electric water purifiers for industrial water supplies are now standard articles.

126. Sanitary Engineering.—Questions relating to sewage, baths, and lavatories should receive the attention of capable sanitary engineers.

127. Mechanical Transportation.—In mechanical transportation equipment are included cranes and hoists, trolley tracks and trolleys, automatic conveying apparatus, industrial railway equipment and trucks, also facilities for unloading and loading freight cars and wagons. In regard to cranes it is necessary to determine the span and lift, whether the main crane is to be motor driven or hand propelled, whether the hoist is to be a hand hoist or motor-driven hoist, also whether the hoist and load carried is to run on a drop crane which can make connections with similar drop frames on other cranes in the bays so as to enable the hoist with its load to be transferred from the main aisle into side aisles.

In order to determine the power required for driving electric cranes the following data given by Mr. S. S. Wales, before the Western Society of Pennsylvania are useful:

An electric crane is divided into three general parts—bridge, trolley and hoist, each of which has its own motor and controlling system, and each subjected to different conditions of work.

For the bridge, where the ratio of axle-bearings to diameter of wheel is between 1 to 5 and 1 to 6, the following table will answer our purpose for weights and traction for different spans:

Let L = working load of crane, in tons.
W = weight of bridge alone in tons.
w = weight of trolley alone in tons.
S = speed in feet per minute.
P = pounds per ton required.

Span	W	P
25 ft.	$0.3L$	30 lb.
50 ft.	$0.6L$	35 lb.
75 ft.	$1.0L$	40 lb.
100 ft.	$1.5L$	45 lb.

For the trolley the weight and traction may be assumed as follows:

L	Lb.	P
1 to 25 tons	$0.3L$	30 lb.
25 to 75 tons	$0.4L$	35 lb.
75 to 150 tons	$0.5L$	40 lb.

Power required for bridge:

$$\frac{(L+W+w)\times P\times S}{33{,}000} = \text{horse-power.}$$

As the nominal horse-power rating of a series motor is based on an hour's run with a rise of 75° C. above the surrounding air, and as conditions of bad track, bad bearings, or poor alignment of track wheels may be met with, in factory operation 1 1/2 times the above result should be taken as the proper size motor for the bridge.

For trolley:

$$\text{Horse-power} = \frac{(L+w)\times P\times S}{33{,}000}$$

use factor of 1 1/4 × above for size of motor.

For hoist assume: 1 h.p. per 10 foot-tons per minute of hoisting.

D. Selby Biggs reports following results of a test (Iron and Steel Institute, 1903):

30-ton crane, 25 h.p. motors, 220 volts
Weight............16 tons.

	Horse-power.	
	Max.	Avg.
Heaving	11.1	6.2
Cross travel	9.2	4.4
Longitudinal travel	5.5	0.6

In many cases trolley track and trolleys are desirable for mechanical transportation where the bridge type of crane would be out of the question. In laying out a trolley system it is necessary to determine approximately the location and number of lineal feet of straight trolley rail and approximately the number of feet of curved rail, the number and style of switches, carrying capacity, method of attachment of the trolley rail, number of trolleys and carrying capacity of same.

For sending light trolleys and light materials from central storerooms to branch storerooms, store service apparatus such as cable drives or pneumatic tubes may be found very convenient. The locations of the various stations for such service should be determined in the plans for such systems. With regard to industrial railway equipment the location of the tracks, the weight of same, also the gauge need to be determined, location of switches and turn tables, also the types and number of cars to be used. If locomotives are wanted for the industrial railway system we must determine whether they shall be driven by gasoline engines or storage batteries and electric motors.

With regard to truck systems the main routes need to be laid out; also determine the approximate number of trucks required, location of central depot, number of motor trucks to be used.

The open areas must be wide enough to permit the passage of two trucks in the aisles and the side tracking of trucks around the machines. A truck system involving the retention of the material in the trucks with as little unloading and reloading and with as little hauling of empties as possible is an important feature and one deserving attention in any establishment. It involves the building of a considerable number of trucks and departmental supervision, but is likely to result in economy. In some instances trucks are desirably built so as to pick up and deliver a sheet steel keg for holding working processes. An ample supply of metal "tote boxes" for holding small parts will facilitate stock, moving and lessen losses of small parts. In some establishments the transfer of work in processes from department to department is delegated to a distinct department known as the "stock-moving department." In other establishments the inspection department has jurisdiction over the stock movers. At the Lodge & Shipley Company in Cincinnati an inspector accompanies the motor trucks which move all material duly inspected from one department to another, the inspector handing the tracing department job slips representing work inspected on each trip.

128. Power Generation and Transmission.—Economy usually demands the location of the source of power and heat at the side of the building, somewhat nearer the end which is likely to be elongated. It should be provided with easy means of access for delivery of fuel and for removal of ashes. The use of sloping trestles is often an advantage in bringing cars to the level of upper floors or platforms in the case of power-plant, foundry, etc. A system of outdoor tracks and of outdoor cranes and power shovels should be considered and provided wherever, on investigation, it would appear to be an economic move.

In estimating the total power requirements we need to determine, first, the power required by the processing machinery; second, the power required by the various service equipment other than lights; third, the power required by electric lights.

In determining the power required by various machines it is desirable to secure data from the manufacturers of various machines as to the power requirements of their machinery. If possible these data should be accompanied by actual tests made in the work of the plant itself or in a similar plant.

The following are typical data as furnished by machine tool builders:

HORSE-POWER REQUIRED BY MACHINE TOOLS

Lathes

Lodge & Shipley Machine Tool Company, Cincinnati, Ohio

Swing	Style	Horse-power idle	Horse-power average cut
14 in.	Cone head.........	.31	1.73
14 in.	Patent head.......	.39	2.56
16 in.	Cone head.........	.377	1.93
16 in.	Patent head.......	.53	3.78
18 in.	Cone head.........	.45	3.27
18 in.	Patent head.......	.77	6.28
20 in.	Cone head.........	.53	4.25
20 in.	Patent head.......	1.54	10.55

POWER REQUIRED BY RADIAL DRILLS

Bickford Drill & Tool Company, Cincinnati, Ohio

Working surface	Idle	Average load
No. 1, 2 1/2 ft. × 3 ft.	3/4 h.p.	2 h.p.
No. 2, 2 1/2 ft. × 3 1/2 ft.	3/4 h.p.	3 h.p.
No. 3, 2 1/2 ft. × 4 ft.	3/4 h.p.	3 h.p.

POWER REQUIRED BY MILLING MACHINES

Cincinnati Milling Machine Company, Cincinnati, Ohio

Working surface	Horse-power idle	Average load	Motor recommended
No. 2, 11 ft. × 7 1/4 in.	1/2 h.p.	3 h.p.	5 h.p.
No. 3, 13 1/2 in. × 55 3/4 in.	3/4 h.p.	5 h.p.	7 1/2 h.p.
No. 4, 16 1/2 in. × 64 1/4 in.	1 h.p.	7 1/2 h.p.	10 h.p.
No. 5, 19 in. × 76 1/2 in.	1 1/4 h.p.	10 h.p.	12 1/2 h.p.

POWER REQUIRED BY UPRIGHT DRILLS

Cincinnati Machine Tool Company, Cincinnati, Ohio

Swing	Average horse-power
21 in.	3/4 h.p.
24 in.	1 1/2 h.p.
28 in.	2 h.p.
32 in.	2 h.p.
36 in.	3 h.p.
42 in.	3 h.p.

HORSE-POWER REQUIRED BY PLANERS

American Tool Works Company, Cincinnati, Ohio

22 in. and 24 in. planers	2 1/2 to 3 1/2 h.p.
24 in. to 30 in. planers	4 to 5 h.p.
30 in. to 36 in. planers	6 to 8 h.p.
36 in. h.p.	12 to 15 h.p.

HORSE-POWER REQUIRED BY SHAPERS

American Tool Works Company, Cincinnati, Ohio

15 in. shaper	1 1/2 to 2 1/2 h.p.
16 in. shaper	2 to 3 h.p.
18 in. shaper	2 to 5 1/2 h.p.
21 in. shaper	3 to 6 h.p.
25 in. shaper	4 to 6 h.p.
30 in. shaper	5 1/2 to 7 1/2 h.p.

HORSE-POWER REQUIRED BY SHAPERS

Cincinnati Shaper Company, Cincinnati, Ohio

	H.p. idle	H.p. light load	H.p. med. load	H.p. heavy load
16 in. G. G.	0.5	0.75	1.0	2.0
16 in. B. G.	1.0	2.0	3.5	5.0
20 in. B. G.	1.2	2.5	4.0	6.0
24 in. B. G.	1.5	3.0	5.0	7.0

HORSE-POWER REQUIRED BY GEAR CUTTERS

Cincinnati Shaper Company, Cincinnati, Ohio

	H.p. idle	H.p. light load	H.p. med. load	H.p. heavy load
26×10	0.8	1.5	2.5	4.0
36×12	1.2	2.0	4.0	6.0

A number of data on horse-power required for driving machine tools are given in data sheets from *Machinery*, No. 12, September, 1902.

The average power losses in a motor shaft drive and countershaft are given by C. H. Benjamin as 25 per cent., hence after having determined the horse-power required by the various machines 25 per cent. should be added for the losses due to shaft, countershaft and belt drive.

129. Floors.—Factory floors are often responsible for much discomfort. The wood floor is the only one that is conducive to comfort, since wood is a poor conductor of heat. Hence the wooden shoes worn in many cold and earthen-floored foreign shops, the object being to keep the feet less cold. A wood surface on concrete floors is advantageous for other reasons than those of comfort. The dust from concrete when it is abraded is injurious to machined surfaces. Moreover, a wood floor furnishes a good grip for bars used in moving heavy castings, machines, etc. Short lengths of hard maple, even of poor grade, are to be preferred to softer woods for flooring. The short lengths facilitate repairing. The best floors for factories are constructed of 3-in. yellow pine flooring, grooved on both sides and with separate tongues. The separate tongue makes it possible to take up and remove or repair the floor with very little waste. This yellow pine floor is next covered with a sound deadener of tarred paper, and on top of this is placed the surfacing of 3/4-in. hard maple.

For heavy machines and on testing floors, metal floor plates with "T" slots, sunk in concrete, are often desirable.

In ground floors made of concrete with wood surfaces, it has been found that asphalt or coal tar mixed with the concrete, or used as a surfacing, prevents the rise of moisture through the concrete to the hard-wood surfacing. The most satisfactory ground floors are constructed with steel "I" beams, laid in concrete, with asphalt moisture-proof coat and hard-wood surface.

130. Structural and Architectural Details.—In designing factory buildings considerations of utility and economy must come first, and architectural effects must subserviently adapt themselves to these prime requisites. The building must be designed with regard to intake and output, adapting the arrangement to the equipment and flow of work, following always the lines of least resistance as regards both losses in transmission apparatus and losses in activity of live operators.

The general form of the framing of the building designed to conform with the ideas suggested will not include many varieties. It may have the central monitor with sloping sides, the central monitor with saw-tooth construction on the sides, or the entire shop may be of the saw-tooth roof construction. The central monitor gives a more pleasing architectural effect than the saw-tooth roof over the whole building, although the monotony of a saw-tooth roof structure is easily relieved by a multi-floored administration portion. Fig. 25 is a view of the Potter & Johnston Co. factory at Pawtucket, R. I., a good example of the last-mentioned style.

It is not the aim of this presentation to take up such features of building construction as have not directly to do with the productive output. Hence it will be unnecessary to treat of such matters as materials for foundations, side-walls, framework, roof, paint, etc., excepting to reaffirm the general statement that inasmuch as interest and depreciation affect costs of production, as they are greater or less, so it is desirable to construct that type of building which will result in least total sum of combined interest, depreciation, and insurance.

The very cheapest factory building can be constructed of wood framing of just sufficient strength to withstand the stresses to which it is subjected, and covered with corrugated steel siding and tar paper or asbestos paper roofing. Such construction involves a rather high insurance rate, high cost for heating, depreciates rapidly, and is unsafe. The slow-burning type of wood construction uses much heavier timbers for framing and thick flooring, the idea being that, coupled with a good automatic sprinkling system, no fire can gain great headway, and that only the surfaces of timbers, or certain sections of the building, will be destroyed. The slow-burning all-wood type of construction is apt to be no more expensive and a better fire-risk than light steel and brick construction. A more permanent building than the all-wood slow-burning type, and a better fire-risk than the light steel and brick, is presented in the brick and wood slow-burning type of construction. This last-named type of construction is apt to fill in most cases the requirement of that type of building which presents the lowest combined charges for interest, depreciation, and insurance, although its cost is but slightly exceeded by a construction of reinforced concrete, which will be accompanied by still lower fire insurance rates. Reinforced concrete presents difficulties in tearing down which may in some cases cause a preference for slow-burning brick and wood.

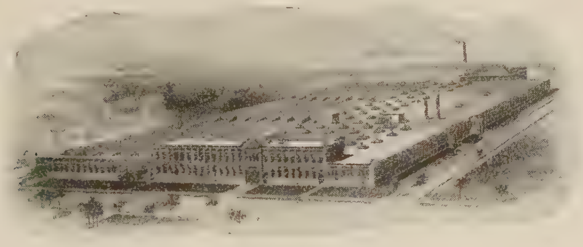


Fig. 25.—Factory of Potter & Johnson Co., Pawtucket, R. I., showing administration front, saw-tooth shop, and power plant, all practically under one roof.

In designing a building it must be borne in mind that while it must be so planned as to place to greatest advantage the machinery of manufacture, there will always be a great deal of work that depends upon human attendance, and that it is just as important that the human machinery be provided with such surroundings and arrangements as will make it the most efficacious. Such arrangements are too often looked upon as philanthropic or advertising measures, when in fact they are part of the productive equipment. The output of man as a machine is regulated first of all by the amount and quality of fuel or nourishment supplied, as food and air and heat. Poor air and insufficient light and warmth inevitably result in poor work, both as regards quantity and quality, even though the workers might be picked for their cheerful and sunny dispositions. But another factor enters, namely, that of contentment. Agreeable and healthful surroundings will tend more than anything else to remove the chief cause, next to lack of proper and sufficient vital supplies, which is responsible for diminished labor efficiency, namely, discontent. Hence it becomes important to consider what features of building construction influence comfort.

Except when specific reasons to the contrary appear, the cheapest building is to be constructed in which it is physically possible to do the work well. A building must provide shelter from weather, afford good light and ventilation, and must be able to resist all stresses to which it is subjected by equipment and employees, besides offering reasonable resistance to weather and conflagration. Beyond these considerations any additional elaborations are excusable only when charged to advertising account.

For psychological reasons it is desirable that the building present a pleasing appearance rather than that of an ugly monster or prison. Hence any architectural artifices are to be commended that will relieve monotonous continuity, such as in the case of a long building, the use of projecting pilasters, which also add to the rigidity of the structure, or the use of external projections for elevator shafts, stairways, or lavatories, if such a location is found otherwise desirable. Where a low building with central monitor and single gallery is used, it may be desirable to have elevators and stairways at the inside of the gallery on account of their thus feeding a wider territory with a shorter amount of walking and hauling than they would if placed at the outer walls.

An architect with an eye for beauty will know of many devices for making an ugly sky-line pleasing, converting a plain stairway at the front or side of a building into a pleasing terrace, etc.

When, by reason of increased business, a manufacturing establishment finds it necessary to erect an extension or to put up a new plant, the progressive firm seldom plunges headlong into building. The necessity for alteration leads to a careful investigation of such matters as the travel of work through the factory, the maintenance of proper balance of floor area, the provision for a rational growth, an investigation of processing and service equipment, and other important considerations.

131. Employment of Professional Industrial Engineers to Aid in Planning of Buildings.—In the planning of extensions and new buildings, the owners of a business will usually find it most profitable to employ the services of an experienced industrial engineer or firm of industrial engineers to relieve their own superintending staff from the additional labor involved in such planning—a strain which, without outside assistance, might seriously handicap the regular productive work of the factory. Usually the industrial engineer should be retained and allowed to complete his plans and reports prior to the engagement of an architect, as the structural and architectural features cannot be intelligently handled until the industrial engineer's work is practically completed. Conferences and consultations should be arranged for between the architects and industrial engineers before final contracting is done.

REFERENCES

Ennis: "Works Management," Chapter X.

Tyrrell: "Engineering of Shops and Factories," Chapters III to XXX.

Perrigo: "Modern Machine Shop Construction, Equipment and Management," Chapters I to XV.

Day: "Industrial Plants."

Schneider: "Specifications for Buildings."

CHAPTER IX

EMPLOYMENT OF LABOR AND LABOR PROBLEMS

132. Labor Bureau.—In a very large factory, employment of labor is such an important problem that the entire attention of one man, and frequently of several assistants, is required to take care of hiring, wages, and efficiency records. Frequently problems dealing with welfare and betterment work and industrial education are handled by this same bureau. The problem of selecting the right man for a given job and the right job for a given man requires a knowledge of characteristics of men from a psychologic and physical standpoint as well as a knowledge of the requirements of the job.

133. Desirable Qualifications of Employees.—Taylor lists the following nine qualities as those which he states go to make up a well-rounded man: (1) brains; (2) education; (3) special or technical knowledge; manual dexterity or strength; (4) tact; (5) energy; (6) grit; (7) honesty; (8) judgment or common sense; (9) good health. He adds that plenty of men who possess only three of these qualities can be hired at any time for laborer's wages; add four of these qualities together and you get a higher-priced man; the man who combines five of these qualities begins to be hard to find. Those with six, seven, and eight are almost impossible to get.

Doctor Katherine Blackford sets forth as fundamental requirements of all employees: health, intelligence, honesty, and industry. Doctor Blackford has gathered interesting statistics showing according to her deductions definite relationships between texture of skin and flesh, physiognomy and complexion, and psychologic characteristics.

Sheldon classifies qualities of men as (1) mental faculties (objective) including reasoning, judgment and recollection; (2) mental faculties (subjective) including intuition, memory and emotion; (3) physical qualities, including health, strength and vigor; (4) moral qualities including honesty, industry, loyalty, enthusiasm and temperance.

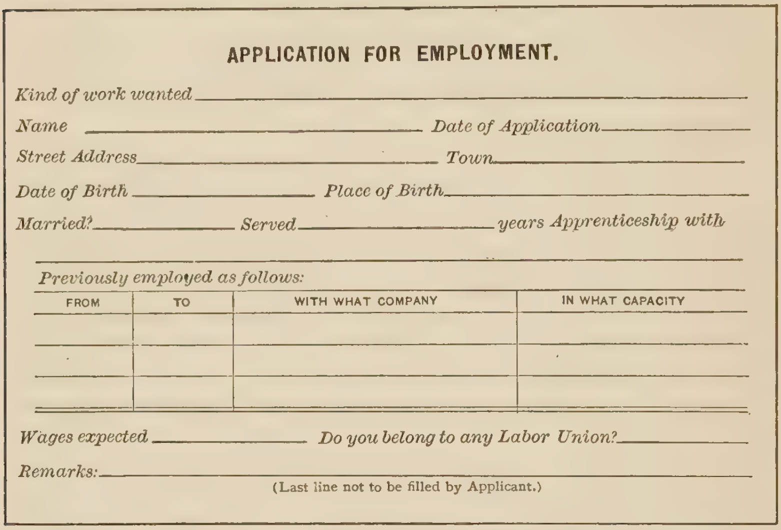
Doctor Blackford's mode of classification affords a good basis for systematic selection of men. Sheldon's philosophy is founded on the belief that by training, suggestion and education, latent positive or desirable qualities can be developed, and negative qualities and habits eliminated. Sheldon's philosophy should prove useful in the upbuilding of an existing set of employees to higher standards.

Vocational guidance bureaus are beginning to gather data based on psychologic and physical measurements and records of family history, environment, and education, which will prove of inestimable value in the future in the matter of selection of employees for given work and the selection of the most appropriate work for given individuals. If we combine Sheldon's philosophy of the certain possibility of improvement with Dr. Blackford's methods and the methods of vocational guidance bureaus, we can easily refute the notion that there is any fatalistic predestination as to the occupation of every individual; vocational guidance supplies for the present only the best man for a given job and the best job for a given man. It does not follow at all that that man must spend his life at that job. It lies with the individual man and with his employers to fit him for greater efficiency.

Doctor Munsterberg has made some most interesting studies in determining the qualifications required for greatest efficiency in certain occupations such as telephone service, electric railway service, ship service, etc. The correctness of his tests is proven by the certainty with which the tests reveal individuals fitted for the employment for which the tests have been devised, and eliminate those not fitted for it.

Munsterberg selects three purposes of business life: (1) To find the men whose qualities make them best fitted for the work they have to do; (2) to find the psychologic conditions which will secure the greatest and most satisfactory output of work from every individual; (3) to produce most completely the influences on human minds, which are desired in the interest of business. In other words, we must answer the questions how to find the best possible man, how to produce the best possible work, and how to secure the best possible effects.

134. Applications for Employment.—A form to be used in keeping record of applications for employment is shown in Fig. 26. These applications are best filed according to the kind of work, the guide card specifying whether lathe hands, milling-machine hands, etc.



APPLICATION FOR EMPLOYMENT.

Kind of work wanted ______________________________

Name ______________________ *Date of Application* ______________

Street Address ______________________ *Town* ______________

Date of Birth ______________ *Place of Birth* ______________________

Married? __________ *Served* ______________ *years Apprenticeship with*

____

Previously employed as follows:

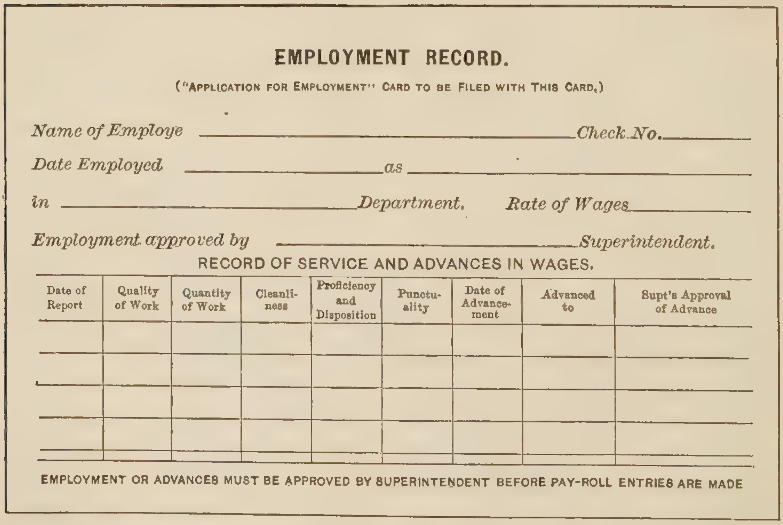
FROM	TO	WITH WHAT COMPANY	IN WHAT CAPACITY

Wages expected ______________ *Do you belong to any Labor Union?* __________

Remarks: ____

(Last line not to be filled by Applicant.)

FIG. 26.—Application for employment record. White card, 6 inches wide, 4 inches high.



EMPLOYMENT RECORD.

("APPLICATION FOR EMPLOYMENT" CARD TO BE FILED WITH THIS CARD.)

Name of Employe ______________________________ *Check No.* __________

Date Employed ______________ *as* ______________________

in ______________________ *Department.* *Rate of Wages* __________

Employment approved by ______________________ *Superintendent.*

RECORD OF SERVICE AND ADVANCES IN WAGES.

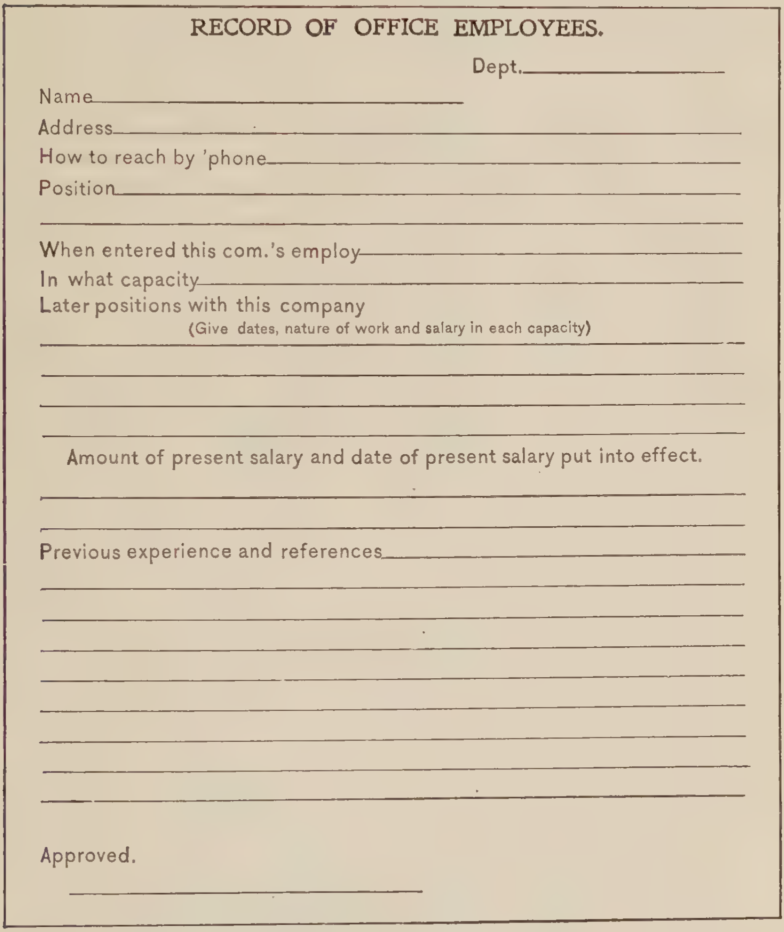
Date of Report	Quality of Work	Quantity of Work	Cleanliness	Proficiency and Disposition	Punctuality	Date of Advancement	Advanced to	Supt's Approval of Advance

EMPLOYMENT OR ADVANCES MUST BE APPROVED BY SUPERINTENDENT BEFORE PAY-ROLL ENTRIES ARE MADE

FIG. 27.—Employment record. White card, 6 inches wide, 4 inches high.

135. Employment Record.—As soon as an applicant is employed, it is desirable to fill out a more comprehensive record than is contained in the application for employment. Fig. 27 is a form for employment record. This record, it will be noted, serves also as a record of service and advance in wages.

136. Record of Office Employees.—A form for building up a record of office employees is shown in Fig. 28.



RECORD OF OFFICE EMPLOYEES.

Dept.

Name

Address

How to reach by 'phone

Position

When entered this com.'s employ

In what capacity

Later positions with this company

(Give dates, nature of work and salary in each capacity)

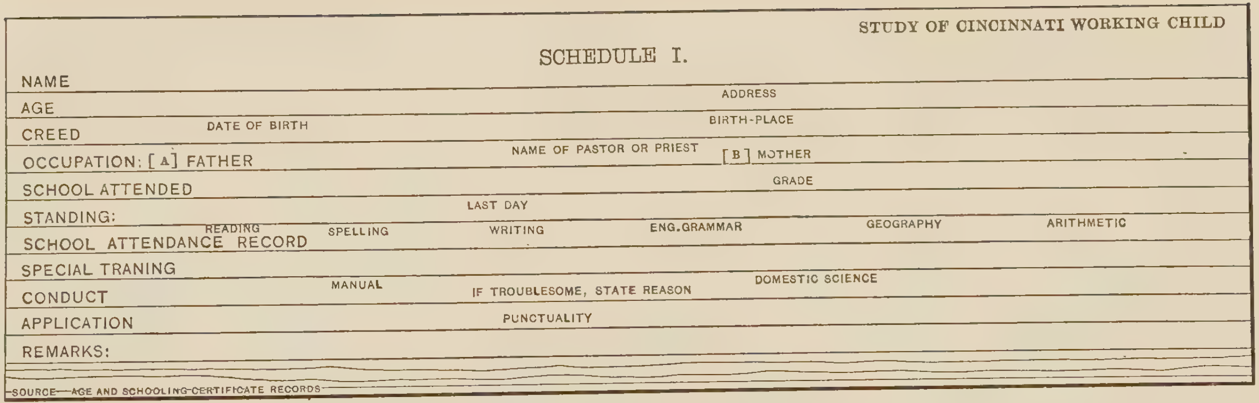
Amount of present salary and date of present salary put into effect.

Previous experience and references

Approved.

Fig. 28.—Form for employment record of office employees. White paper, 8 1/2 inches wide, 11 inches high.

137. Psychologic and Physical Tests, Industrial and Family History.—The foregoing employment records include pretty nearly all the data on which satisfactory returns can be obtained through the medium of reports from the average foreman and



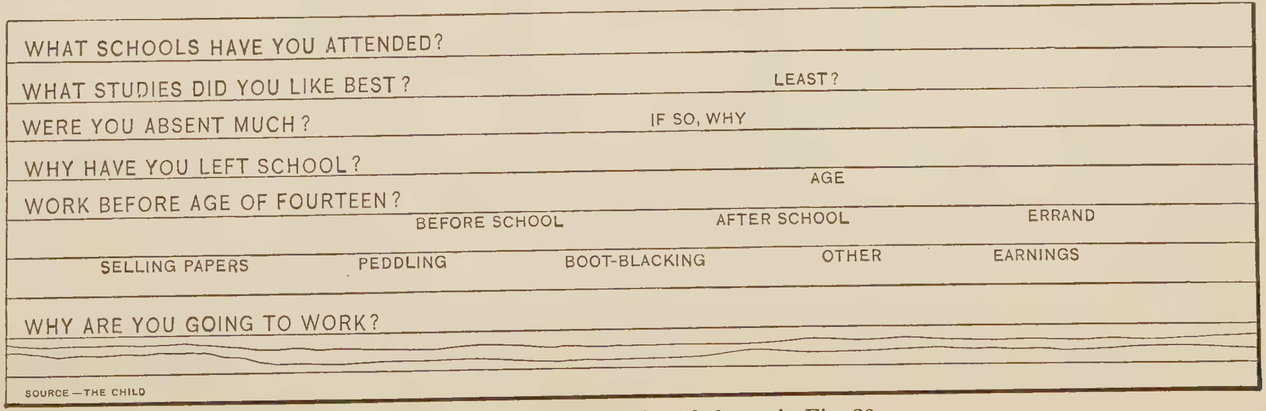
STUDY OF CINCINNATI WORKING CHILD

SCHEDULE I.

NAME
AGE ADDRESS
CREED DATE OF BIRTH BIRTH-PLACE
OCCUPATION: [A] FATHER NAME OF PASTOR OR PRIEST [B] MOTHER
SCHOOL ATTENDED GRADE
STANDING: LAST DAY
SCHOOL ATTENDANCE RECORD READING SPELLING WRITING ENG. GRAMMAR GEOGRAPHY ARITHMETIC
SPECIAL TRANING
CONDUCT MANUAL IF TROUBLESOME, STATE REASON DOMESTIC SCIENCE
APPLICATION PUNCTUALITY
REMARKS:

SOURCE—AGE AND SCHOOLING-CERTIFICATE RECORDS

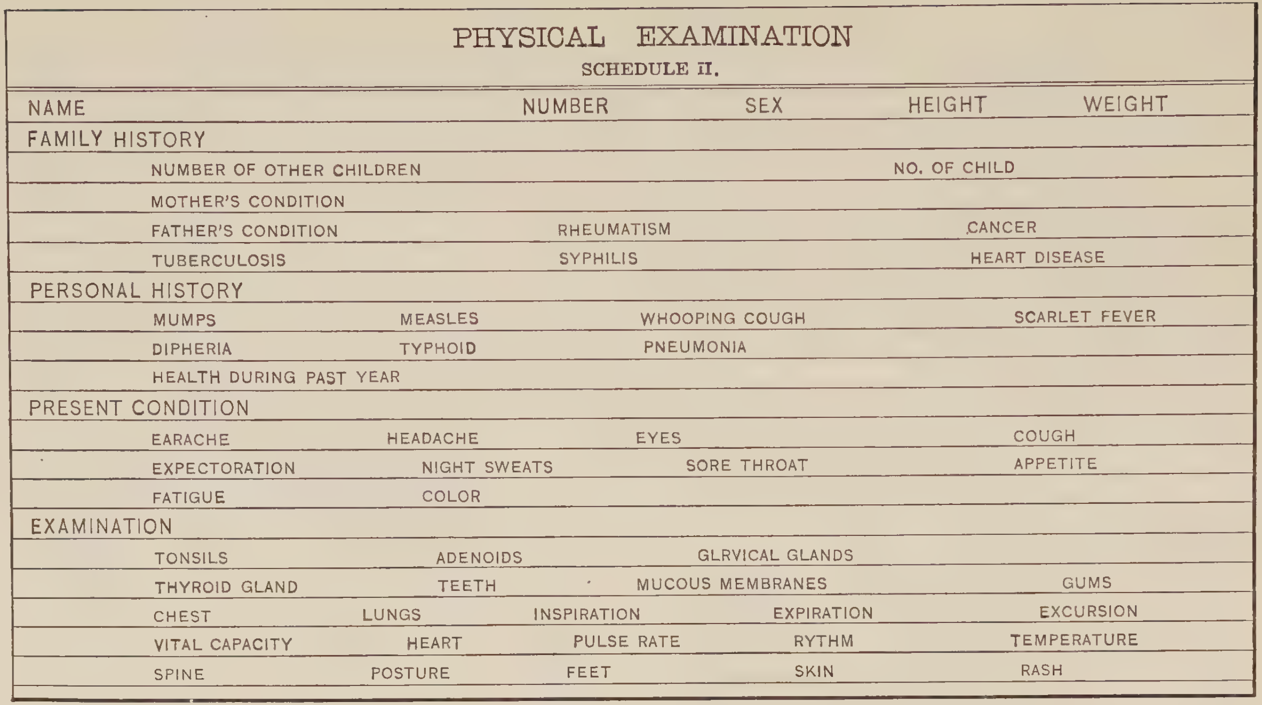
Fig. 29.—School record of applicant (front). White card 5×8.



WHAT SCHOOLS HAVE YOU ATTENDED?
WHAT STUDIES DID YOU LIKE BEST? LEAST?
WERE YOU ABSENT MUCH? IF SO, WHY
WHY HAVE YOU LEFT SCHOOL?
WORK BEFORE AGE OF FOURTEEN? AGE
BEFORE SCHOOL AFTER SCHOOL ERRAND
SELLING PAPERS PEDDLING BOOT-BLACKING OTHER EARNINGS
WHY ARE YOU GOING TO WORK?

SOURCE—THE CHILD

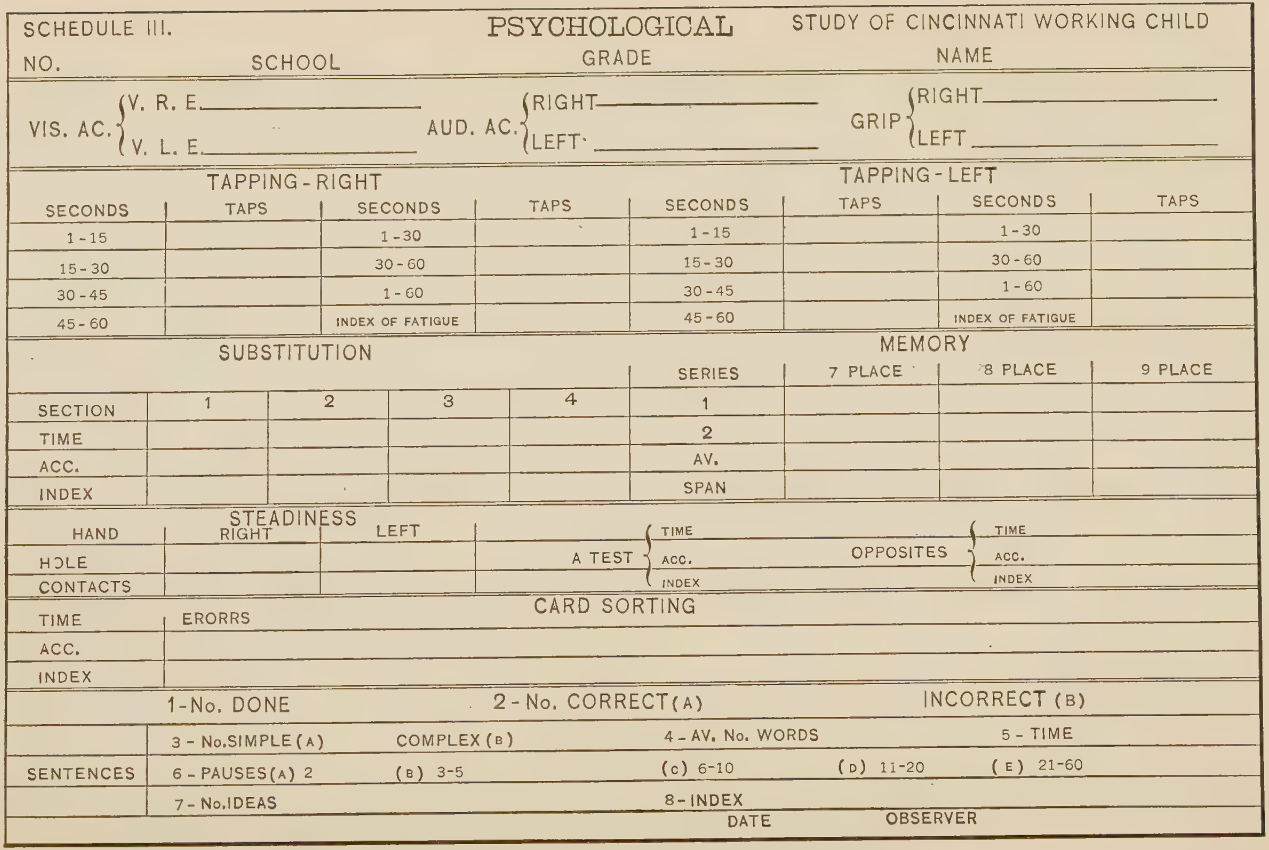
Fig. 30.—Reverse side of card shown in Fig. 29.



PHYSICAL EXAMINATION
SCHEDULE II.

NAME NUMBER SEX HEIGHT WEIGHT
FAMILY HISTORY
NUMBER OF OTHER CHILDREN NO. OF CHILD
MOTHER'S CONDITION
FATHER'S CONDITION RHEUMATISM CANCER
TUBERCULOSIS SYPHILIS HEART DISEASE
PERSONAL HISTORY
MUMPS MEASLES WHOOPING COUGH SCARLET FEVER
DIPHERIA TYPHOID PNEUMONIA
HEALTH DURING PAST YEAR
PRESENT CONDITION
EARACHE HEADACHE EYES COUGH
EXPECTORATION NIGHT SWEATS SORE THROAT APPETITE
FATIGUE COLOR
EXAMINATION
TONSILS ADENOIDS GLRVICAL GLANDS
THYROID GLAND TEETH MUCOUS MEMBRANES GUMS
CHEST LUNGS INSPIRATION EXPIRATION EXCURSION
VITAL CAPACITY HEART PULSE RATE RYTHM TEMPERATURE
SPINE POSTURE FEET SKIN RASH

FIG. 31.—Physicians report of physical examination. Salmon color card 5×8.



SCHEDULE III. PSYCHOLOGICAL STUDY OF CINCINNATI WORKING CHILD

NO. SCHOOL GRADE NAME

VIS. AC. {V. R. E.____ V. L. E.____ AUD. AC. {RIGHT____ LEFT____ GRIP {RIGHT____ LEFT____

TAPPING-RIGHT				TAPPING-LEFT			
SECONDS	TAPS	SECONDS	TAPS	SECONDS	TAPS	SECONDS	TAPS
1-15		1-30		1-15		1-30	
15-30		30-60		15-30		30-60	
30-45		1-60		30-45		1-60	
45-60		INDEX OF FATIGUE		45-60		INDEX OF FATIGUE	

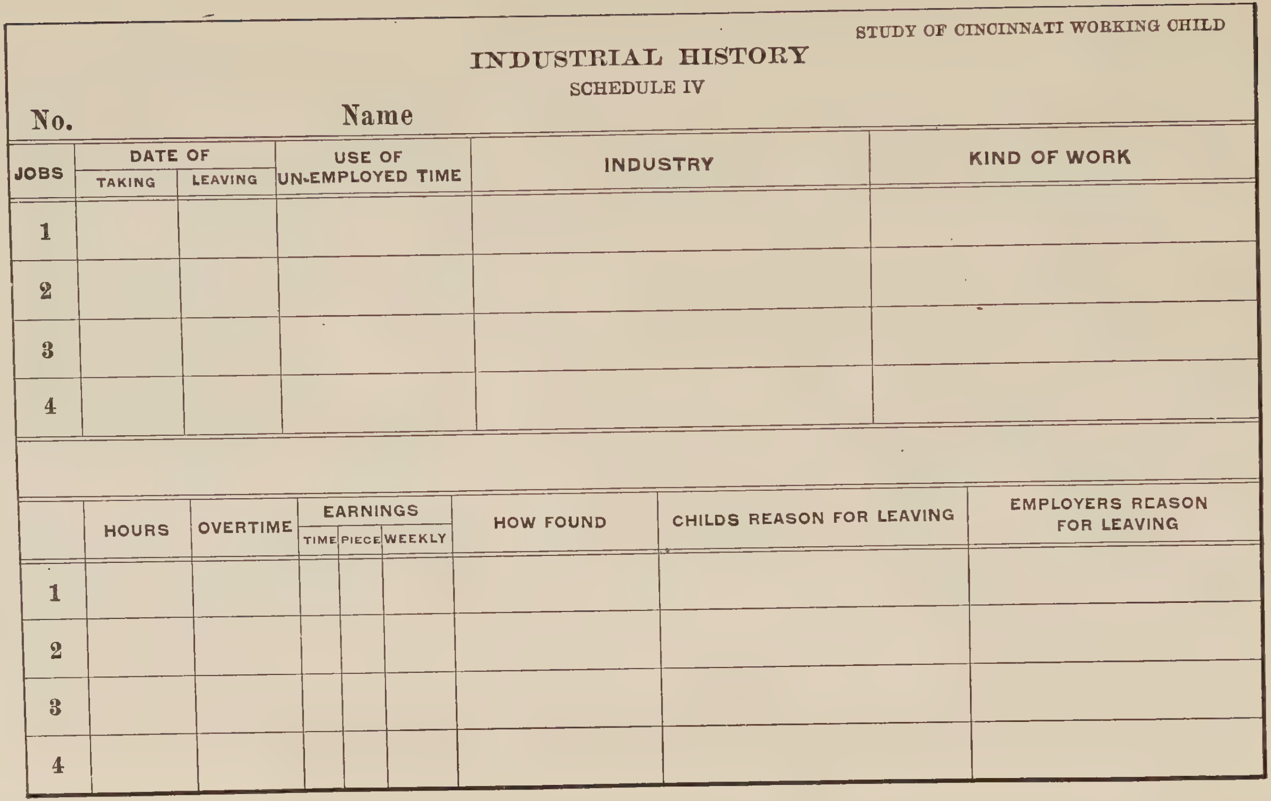
SUBSTITUTION					MEMORY			
					SERIES	7 PLACE	8 PLACE	9 PLACE
SECTION	1	2	3	4	1			
TIME					2			
ACC.					AV.			
INDEX					SPAN			

STEADINESS						
HAND	RIGHT	LEFT	A TEST	TIME	OPPOSITES	TIME
HOLE				ACC.		ACC.
CONTACTS				INDEX		INDEX

CARD SORTING	
TIME	ERORRS
ACC.	
INDEX	

	1-No. DONE		2-No. CORRECT (A)		INCORRECT (B)
	3-No. SIMPLE (A)	COMPLEX (B)	4-AV. No. WORDS		5-TIME
SENTENCES	6-PAUSES (A) 2	(B) 3-5	(C) 6-10	(D) 11-20	(E) 21-60
	7-No. IDEAS		8-INDEX		
			DATE	OBSERVER	

FIG. 32.—Psychological test record. Buff color card 5×8.



STUDY OF CINCINNATI WORKING CHILD

INDUSTRIAL HISTORY
SCHEDULE IV

No. Name

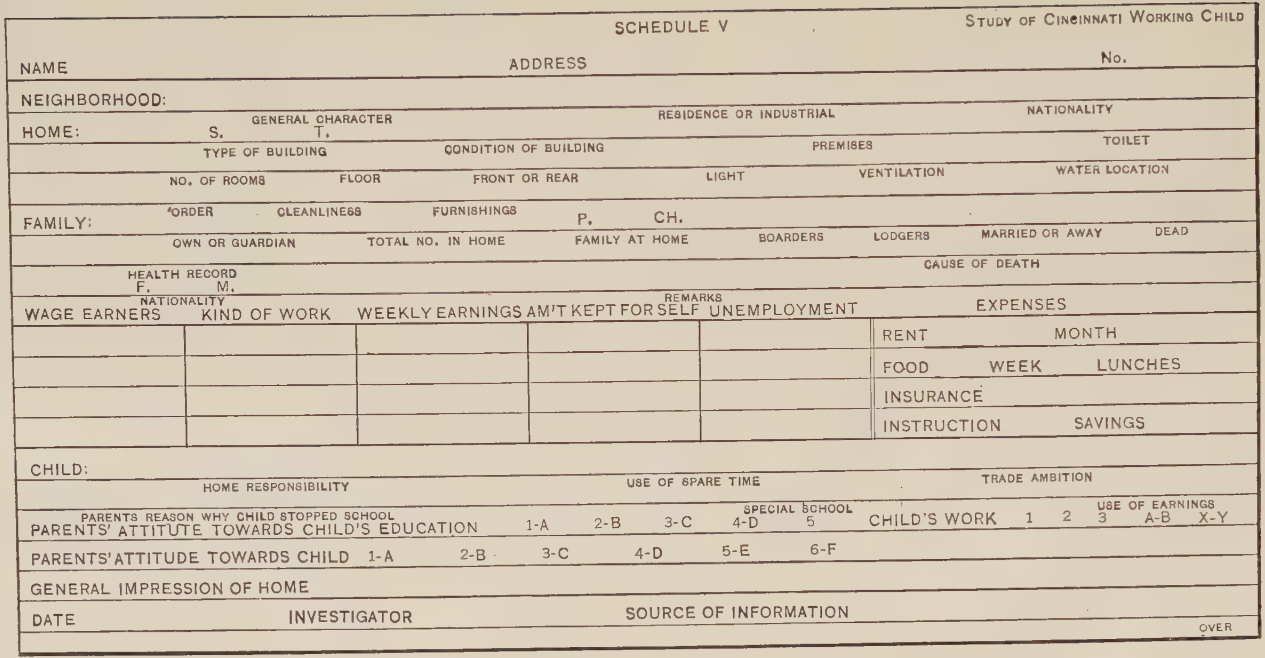
JOBS	DATE OF		USE OF UN-EMPLOYED TIME	INDUSTRY	KIND OF WORK
	TAKING	LEAVING			
1					
2					
3					
4					

	HOURS	OVERTIME	EARNINGS			HOW FOUND	CHILDS REASON FOR LEAVING	EMPLOYERS REASON FOR LEAVING
			TIME	PIECE	WEEKLY			
1								
2								
3								
4								

FIG. 33.—Industrial history (front). White card 5×8.

JOBS	1	2	3	4
1 EASE OF FINDING				
2 FATIGUE a				
b				
3 EARNINGS a				
b				
4 APPRENTICE a				
b				
5 CONTINUATION OF EDUCATION				
6 RELATION OF STUDIES TO WORK				
7 ENJOYMENT OF WORK				
8 FREE TIME				
9 WORK AND SCHOOL a				
b				
10 COMBINATION OF WORK & SCHOOL				

Fig. 34.—Reverse side of industrial record shown in Fig. 33.



SCHEDULE V STUDY OF CINCINNATI WORKING CHILD

NAME ADDRESS No.

NEIGHBORHOOD:

HOME: GENERAL CHARACTER S. T. RESIDENCE OR INDUSTRIAL NATIONALITY

TYPE OF BUILDING CONDITION OF BUILDING PREMISES TOILET

NO. OF ROOMS FLOOR FRONT OR REAR LIGHT VENTILATION WATER LOCATION

FAMILY: ORDER CLEANLINESS FURNISHINGS P. CH.

OWN OR GUARDIAN TOTAL NO. IN HOME FAMILY AT HOME BOARDERS LODGERS MARRIED OR AWAY DEAD

HEALTH RECORD F. M. CAUSE OF DEATH

WAGE EARNERS	NATIONALITY KIND OF WORK	WEEKLY EARNINGS	AM'T KEPT FOR SELF	REMARKS UNEMPLOYMENT	EXPENSES
					RENT MONTH
					FOOD WEEK LUNCHES
					INSURANCE
					INSTRUCTION SAVINGS

CHILD:

HOME RESPONSIBILITY USE OF SPARE TIME TRADE AMBITION

PARENTS REASON WHY CHILD STOPPED SCHOOL

PARENTS' ATTITUTE TOWARDS CHILD'S EDUCATION 1-A 2-B 3-C 4-D SPECIAL SCHOOL 5 CHILD'S WORK 1 2 3 USE OF EARNINGS A-B X-Y

PARENTS' ATTITUDE TOWARDS CHILD 1-A 2-B 3-C 4-D 5-E 6-F

GENERAL IMPRESSION OF HOME

DATE INVESTIGATOR SOURCE OF INFORMATION

OVER

FIG. 35.—Economic data regarding applicant. Green color card 5×8 in.

timekeeper. It is quite apparent that if we are to apply modern principles of intelligent selection of employees and training them to higher efficiency, we must build up more comprehensive data as a working basis for the trained expert in our labor bureau who will keep up this important part of the establishment's activity. Figs. 29 to 35 inclusive are here given to indicate the comprehensiveness of such records as are necessary to afford a basis for intelligent selection and placing of employees and for progressive training to higher efficiency of apprentices and such older employees as will avail themselves of such opportunities as continuation school, part-time school, or night school. The forms given here are in use at the Vocational Guidance Bureau of Cincinnati. Schedule I is the school record, Schedule II the record of Physical Examination, Schedule III the record of Psychologic tests and measurements, Schedule IV, the individual's industrial history, Schedule V, Economic data regarding the individual's home, family and earnings.

RELEASE CARD.

PAY ROLL DEPARTMENT MUST BE NOTIFIED AS SOON AS ANY EMPLOYE IS LAID OFF, DISCHARGED, OR QUITS VOLUNTARILY.

Date ______________ *Mr.* ______________________________ *Check No.* __________

has this day and hour { *been "laid off"* / *been discharged* / *quit voluntarily* } ______________ *A.M.* ______________ *P.M.*

Reasons assigned ______________________________

____

____

He has turned in all Checks, Tools, Wrenches, etc., the property of this Company, and is entitled to his wages in full.

____

Dept. Foreman. *Tool Room Foreman.*

Noted ______________________________ *Superintendent.*

Fig. 36.—Release card. White card, 6 inches wide, 4 inches high.

The problem of satisfactory labor is one which goes far beyond the mere matter of keeping record of the men's previous employment or their promptness and regularity of present service.

138. Release Cards.—When a man leaves he should be given a release card which serves as a notice to the pay-roll department.

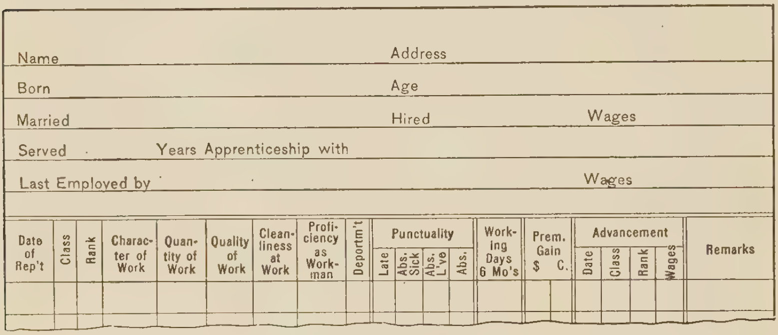
Fig. 36 shows such a release card, which must be signed by the tool-room foreman and department foreman, showing that the man leaving has turned in all tools, checks, and other property of the company, and that he is entitled to his wages in full, or minus certain deductions for unreturned checks, tools, etc.

139. Cipher Code of Characteristics of Employees and Ex-employees.—In order to keep information confidential, the following cipher code, or one similar to it, may be very advantageous: (In the example given, the figures corresponding to the various traits have been purposely disarranged so as not to reveal the cipher.)

1. Laid off.
2. Discharged.
3. Quit.
4. Struck.
5. Trouble with foreman.
6. Trouble with other employees.
7. Wanted higher wages or piece rate.
8. Wanted shorter hours.
9. Objected to piece work.
10. Objected to premium system.
11. Bad health.
12. Too old.
13. Too young.
14. Better job.
15. Did not report for work.
16. No work.
17. Not suited to class of work.
18. Skill, excellent.
19. Skill, average.
20. Skill, poor.
21. Production, fast.
22. Production, medium.
23. Production, slow.
24. Interested; ambitious.
25. Careless; indifferent.
26. Obedient; reliable.
27. Disobedient; unreliable.
28. Diligent; energetic.
29. Indolent; wastes time.
30. Prompt; regular.
31. Not prompt; irregular.
32. Good disposition.
33. Bad disposition.
34. Non-union man.
35. Union man.
36. Loyal; faithful.
37. Discontented; unreasonable.
38. Agitator; trouble maker.
39. Untruthful.
40. Dishonest.
41. Intemperate.
42. Striker.
43. Talks too much.
44. Borrows money; dead beat.
45. Desirable man.
46. Undesirable man.

140. Efficiency Records.—Efficiency records may be made much more useful and specific in a shop using piece-work, bonus, or premium system, than in a shop where the efficiency records are based wholly on the opinions of foremen. A well-conducted shop will keep an efficiency record of employees in the ranks that will enable the labor superintendent to encourage and keep the best workers, and to weed out the bad ones. Many shops have an employment record giving sundry details as to a man's street address, previous employment, the size of his family, etc., but

I have seen few of even such meager records as are kept intelligently and in good order, and which are ever studied or frequently consulted. I have introduced individual workmen's records showing each man's successes and failures in merit wage systems, but I have found it difficult to secure the careful study of these efficiency records which should be accorded them by persons in authority. What use can be made of such records? If we discharge the inefficient workers, what guarantee have we that new men will be more efficient? To this question I would answer that the efficiency records will reveal to us which men need to be given



Name Address

Born Age

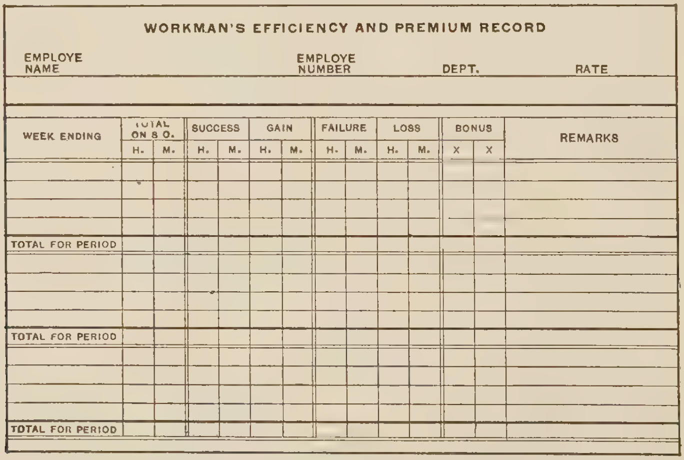
Married Hired Wages

Served · Years Apprenticeship with

Last Employed by Wages

Date of Rep't	Class	Rank	Character of Work	Quantity of Work	Quality of Work	Cleanliness at Work	Proficiency as Workman	Deportm't	Punctuality				Working Days 6 Mo's	Prem. Gain		Advancement				Remarks
									Late	Abs. Sick	Abs. L've	Abs.		$	C.	Date	Class	Rank	Wages	

FIG. 37.—Efficiency record. (General.) White card, 6 inches wide, 4 inches high.



WORKMAN'S EFFICIENCY AND PREMIUM RECORD

EMPLOYE NAME EMPLOYE NUMBER DEPT. RATE

WEEK ENDING	TOTAL ON S O.		SUCCESS		GAIN		FAILURE		LOSS		BONUS		REMARKS
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	X	X	
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													

FIG. 38.—Record of efficiency and earnings under combined premium and bonus system. White card, 6 inches wide, 4 inches high.

a chance to do better work, and they will show also which men in the shop are most capable of showing them. The workingman will take more kindly to a demonstrator selected from among his peers and fellows than to a speed boss or speed expert hired from abroad. It is easy to pick out in a machine shop one's best milling-machine hand, the best lathe hand, the best drill-press hand, and by paying a higher hourly rate while on demonstrating work, to have them serve as instructors to the poorer men. The great majority of men who have fallen below a standard of good performance will make a success of their tasks when helped in this way. Fig. 37 shows a form for efficiency record. An additional form is shown in Fig. 38, showing efficiency under bonus wage system.

141. Sanitation, Accident and Fire Prevention.—There has been a marked tendency of late years to include sanitation, accident and fire prevention among the activities of the labor bureau. The technical features of these important elements should be delegated to a man with the requisite engineering education to work out.

142. Apprenticeship System.—Another phase of the human side of the shop which requires more attention than is usually given it is the apprenticeship system. In most shops this is a farce. Some of the larger shops, however, are introducing apprentices' schools, and paying attention to the character of the boys they are employing, weeding out the undesirable ones and holding tight to the good ones.

No matter how we may scoff at paternalism and the coddling of the workman, there is no denying the fact that to make better men and women of the rank and file is a great fundamental step in the direction of a disposition on the part of the employees to become better help. Give them better air and better surroundings and they will have better health and better dispositions. But we must do more than this. We must have better craftsmen with better technique in their trades. It is right here that we are weakest, and it is here that we will first feel foreign competition. The all-around machinist is almost extinct—the man who knows how to get best results out of a lathe, a milling machine, a planer, a shaper, a drill press, and a boring mill. Machine-shop foremen who have advanced from the ranks are as a rule men who are proficient on but one tool, and are not competent judges of the best way to do work on all the different machines even in their own departments. The great majority of workmen in shops to-day have not had any schooling beyond the seventh or eighth grade. Their shop apprenticeship has not made them all-around craftsmen. The philanthropy expended in the erection of manual training high schools has failed to reach the great mass of working people who have never got that far along in school life. It is this great majority of our people who never get beyond the seventh or eighth grade of school that are most in need of further trade education to make them better craftsmen. There is certainly tremendous need for the establishment of real trades schools with the best obtainable really practical instructors for this great class of working people.

143. Suggestion System.—The suggestion system can advantageously be handled by the Labor Bureau: A suggestion system can be made of benefit in any shop, even a small one, but only if handled systematically and intelligently. The men need to have the benefits of the suggestion scheme kept continually before them. This can be done by handing out each month individual slips to every employee announcing the prizes for the coming month. Another means is the printing on the time-slips that show the workman's gains or losses under a merit wage system, of a few words, calling attention to the suggestion scheme, as for instance, "We are always glad to have our men make suggestions for changes in fixtures, appliances, and tools to facilitate the work. If an idea occurs to you, write it out and put it in the suggestion box. Prizes are offered for the best suggestions." Suggestions should be acknowledged by a personal letter to every one making a suggestion. Awards must be intelligently made by competent judges. Suggestions adopted should be put into effect promptly. Foremen should be made participants in the suggestion scheme on a different footing from the men.

144. Social Betterment and Welfare Work.—Many shop superintendents are apt to look unfavorably upon so-called betterment or welfare work as something which smacks of effeminacy and faddism. The workmen themselves are apt to regard it in the same light; especially is this true if the persons engaged in the work are not sincere.

From a shop-owner's standpoint, the ideals to be realized are, first, the producing of a marketable product which will command the highest price of any similar product in its class; second, the producing of the largest possible quantity of this article at the lowest possible cost.

With the development of a better educated and more enlightened purchasing class, it is coming to pass that the shop-owner is beginning to feel that in order to realize the first-named ideal, the quality of his product must be continually improving. The most marketable steam-engine or machine tool of to-day is a product of much higher quality than that which was the most marketable but a few years ago. This realization has resulted in better machinery, and in the employment of better designing talent, and in the introduction of labor systems which seek to attract and hold the better class of mechanics.

The second business ideal, namely, the producing of the largest possible output at the lowest possible cost, involves not only good equipment, good design, and careful mechanics, but the element of human activity. The need for pronounced emphasis on this element is becoming more and more felt by manufacturers. The standpoint of advantage to the shop-owner is usually the only point of view from which the directors will consider welfare and betterment propositions. A good works manager can as a rule find abundant arguments in favor of rational welfare work from this point of view.

The terms "Welfare" and "Betterment work" have been rather loosely used to include practically all of the activities heretofore mentioned in this chapter, such as proper selection of employees, efficiency records, promotion system, apprenticeship system, sanitation, fire prevention, and suggestion system. A better designation would be to include all of the aforementioned activities under the general functions of a labor bureau, as well as the social, athletic, and similar features which contribute to mutual confidence. The popular acceptance of the terms "welfare" and "betterment" is to associate them immediately with company contributions of a philanthropic nature to a great annual picnic, Saturday afternoon baseball, benefit society funds, and similar matters.

In regard to the workingman's home life and his habits, he does not want these interfered with. However, time and again, workingmen have expressed themselves to me in regard to their wishes for better home surroundings. They complain to me in the same way in various cities, that civic improvements are made in those parts of a city occupied by the homes of the well-to-do.

There, they say, they find paved streets, good sidewalks, shade trees, water, sewer connections, electric lights, gas, and street sprinkling, while the workingmen's homes are on muddy streets, no trees, nor sewers, no paving, poor sidewalks, poor lighting at night. Workingmen complain to me that manufacturers are willing to spend time and money to influence councils to secure switches and to secure election to public office of men pledged to grant their corporation special privileges, and that the workingman would like to see these same influences at work to secure public betterment of his home surroundings. This phase of the question is one that can hardly be controlled by the engineer within the walls of the shop, but it is well worth the thought of the shop-owner.

The greatest successes in social betterment work in connection with factories have been accomplished in shops where work is light, such as the manufacture of breakfast foods, chocolate, cash registers, bed-springs, etc. The employees in these shops are more easily reached than are the workers in the foundry, the forge shop, and the heavy machine shop. I have attended entertainments of a high order, given without charge by the owners of one of the largest shops in Chicago, and under the auspices of skilled social settlement workers. Yet they failed to reach the men. I have in mind particularly one evening when the entertainment was a lecture on the Klondike, preceded and followed by music by the shop band. With many thousands to draw from, there was but a half dozen men outside of the band present. The lecture was intensely interesting to me; yet one after another the men went to sleep. There were two reasons for this: first, the men were physically exhausted; second, it was not the type of entertainment that appealed. When the orchestra struck up it was with vigor and abandon, and the men came to "attention" at once. This same large shop, assisted by private donations from large stockholders, instituted much betterment work, including a manual training school for the children of the employees. A minor feature that was a good one was the distribution, on a truck, of bottles of pure sterilized milk sold at cost. But the greatest difficulty encountered here, as in the heavy steel industries about Pittsburg, is the handling of the adult workman engaged in heavy labor. The Pittsburg district abounds with magnificent club buildings, provided with libraries, gymnasiums, social features, etc., open to the laborer who wishes to avail himself of their opportunities, and yet these institutions fail to reach those who most need uplifting. These clubs are taken advantage of by the young college-educated apprentices, shop clerks, and some few of the young men of the higher grade mechanic class. There is great need of successful plans for reaching the heavy labor class, plans which will result in continuous and permanent good.

145. Shop Rules.—Another matter frequently overlooked is the providing of each employee with a full set of shop rules and regulations. The posting of such notices at different places through the works is not a satisfactory plan. Every new employee should be given a booklet on which is written his name and his check number, so that he will consider it his individual property and not throw it away. In the booklet are listed concisely all of the shop rules and regulations. As an example of what such rules and regulations may be, the following is quoted:

1. On entering our employ the time-keeper will provide you with a check number. Do not fail to notify the time-keeper of any change in your address. The tool-room attendant will provide you with tool checks which must be returned to him when you leave. In order to place the responsibility for breakage and loss of small tools, the tool-room will issue no files or hack-saw blades, unless regular order slip is presented, signed by foreman, and bearing check number of man. Checks will not be returned on broken taps, drills, or end mills, unless an order bearing man's check number and signed by the foreman is returned with the broken tool. A record of each man's breakage will be kept in tool-room, and men will be held responsible for an unreasonable amount of breakage.

2. Each employee must personally register at the time-clock at the time he commences and ceases work. As the pay-roll is figured according to registration on time-recorder, you will appreciate the importance of registering correctly. Employees ringing in late will be paid from the nearest quarter hour following time rung in, and must begin work at once on entering shop. All employees will ring clock four times daily, whether going home at noon or not. A record of punctuality is kept for use in connection with record of general proficiency in establishing employees' standing.

NOTE.—Insobriety will not be tolerated. Employees must give reason for absence, and should see that their foreman is notified by phone or otherwise in case of sickness, so that work can be arranged for.

3. You are engaged at so much per hour, and will be paid by the hour. Time over sixty hours per week is paid for at the rate of time and one-quarter for the additional time over sixty hours.

4. Whistle will blow in the morning and after the noon recess two minutes before time to begin work, so that all may have a chance to reach their place before starting whistle, when every one is expected to be at his post ready for work. Just entering the building at starting time will not be satisfactory.

5. You must use the employees' entrance only, at front of building, in entering and leaving premises.

6. Any one wishing permission to leave during working hours must get permission from his foreman, and ring out on time-clock.

7. In case you expect to be absent a number of days, or wish to leave the company's employ, you must obtain regular release card from your foreman before you can receive your pay from cashier.

8. Every one must keep his machine tool or working place as clean as possible. Paper, rags, scraps of food, and tobacco-spit must be kept from shop and wash-room floors. Good air is required for good health and good work. It is the duty of men and foremen to see that the shop is kept clean, properly ventilated, and to do everything else to keep the sanitary conditions in good order.

9. Receiving visitors, lunching or eating, or reading cannot be permitted during working hours. Smoking and "lighting" of pipes, cigars, etc., is absolutely prohibited at any time. This rule is imperative, owing to the inflammable and explosive nature of materials used, and it will be necessary to dismiss any employee disobeying same.

10. It is absolutely necessary to have all time on work going through shop reported correctly. You are therefore requested to see that each job you take hold of has a shop-order tag with it, and also see that the shop-order tag leaves your place with the work. Where stock is drawn from wareroom for first operation, foreman sends tag to wareroom for material, the man in there attaches the tag to the stock and retains warehouse coupon. Workmen must not work on stock of any kind unless shop-order tag accompanies stock. Workmen should count the number of pieces in each lot before commencing work, and, if full quantity called for is not there, report to foreman immediately before beginning on the job. No alterations of any kind are to be made on the face of tag excepting by production department. Necessary changes in quantity are to be made by production department only. In such cases new tag must invariably be issued.

11. In all cases where men are to make more than one piece of a kind, foreman must be called to inspect first piece and pass on it before any others are made. Defective or spoiled pieces must be immediately sent to finished storeroom by foreman.

12. All parts must be made according to blue-prints, which are obtainable at tool-room. No deviation from blue-prints is allowable. This applies to special as well as regular work. Blue-prints must not be

borrowed under any conditions. If a blue-print is out when called for, it is the duty of the tool-room to hunt it up.

13. Should any work be spoiled or any castings prove defective, such pieces must be shown immediately to foreman, who will see that they are sent to finished storeroom, and that any necessary changes in tags are made by production department.

14. An order signed by department foreman must be presented for any material wanted from storerooms. All slips must give an order number of either general or standing order series. Use a separate slip for each separate order number. Positively no material will be issued except in exchange for the order properly filled. No one except storekeepers allowed to handle material. These instructions must be enforced by storekeepers.

15. In all matters pertaining to orders, reports, or any company business, men will consult with and receive orders from foremen of their own departments only, and foremen from superintendent. Orders from office will be given to superintendent and by him to foremen.

16. You are expected to be governed by the above rules, and your compliance with same affects your standing and the permanency of your employment.

REFERENCES

Taylor: "Shop Management," Paragraphs 221–234.
Hartness: "The Human Factor in Works Management."
Redfield: "The New Industrial Day." Chapters VII–IX.
Munsterberg: "Psychology and Industrial Efficiency," Parts I and II.
Gilbreth: "Primer of Scientific Management," Chapter IV and V.
Scott: "Increasing Human Efficiency in Business."
Ruger: "The Psychology of Efficiency."
Goddard: "The Binet-Simon Measuring Scale for Intelligence."
Lodge: "Rules of Management."

CHAPTER X

THE GENERAL OFFICE

146. Functions of General Office.—The general office of a manufacturing establishment usually has charge of the mail distribution, filing of all mail to or from parties outside the establishment, internal mail service, stenographers, telephone system, and attention to all people calling in person.

147. Handling Mail.—The delegation of the duty of opening the mail depends very largely on the nature of the business. It is always desirable to have all mail opened by one man, if the mail feature of the business is not too heavy to permit of this arrangement. In many establishments the mail is opened either by the secretary of the company or by the chief correspondent, the latter being usually the man in direct charge of the general office.

RECEIVED ______________________

BY ______________________

REFERRED TO ______________________

Fig. 39.—Time-stamp showing date and hour of opening mail, by whom it is opened and to whom it is referred.

It is sometimes desirable to use a time-stamp to designate the hour and date of opening the mail, such stamp bearing a space for the entering of the name of the person or department to which the letter or document is referred. Fig. 39 shows such a stamp. An additional stamp, showing the hour and date and name of person answering the letter, is often used, as shown in Fig. 40.

ANSWERED ______________________

BY ______________________

Fig. 18.—Time-stamp showing date and hour of answering letter and by whom it is answered.

If the man who does the stamping of the time of receipt and the distributing of the incoming correspondence is the only one provided with a time-stamp, his time-stamp should not be taken as evidence of laxity of attention on the part of others, since the letter or document may have been delayed in the original party's charge after having been stamped. The question should be very carefully weighed as to whether the advantages gained by the use of a time-stamp are sufficient to overcome the disadvantages incidental to possible internal frictions. Certainly every one likely to be held to account for delays in the handling of documents should be provided with a time-stamp if the system is to be a fair one.

148. Messenger Service.—A messenger service at fixed hours will do much toward promoting promptness in all departments. Where such a system is in use, the head of each department is provided with a three-decked basket, one deck being marked "In," one "Out," and one "File." The messenger leaves the incoming mail in the basket or deck marked "In," and removes the contents of those marked "Out" and "File." Such a system must be made prompt and accurate. Under these conditions it is possible to request heads of departments to resort to a minimum of calling on each other, and to avoid the carrying in person of papers from department to department.

149. Filing System.—All correspondence with people outside the office should be filed under the direction of one chief filing clerk. This filing place should be centrally located so as to be easily accessible to all departments, especially to those who need to consult the files most frequently, such as the sales or purchasing departments. The various departments will soon adapt themselves to this system of a central file, and will find that condensed reference records are more convenient than a continual handling of original letters and documents.

At first sight it might seem somewhat useless to burden the general file with inter-departmental correspondence, but on further reflection it will appear that it is very desirable that the general manager see regularly or occasionally copies of all such correspondence, before it is filed, in order that he may suggest, where necessary, the avoidance of too much correspondence and internal disputes.

In the matter of filing locally at the various departments internal correspondence, it will generally be found that provisions should be made for each head of department to file his inter-departmental letters and instructions, an additional carbon copy of all internal letters and instructions being made so that one can be kept at the department and one sent in for the general manager's scrutiny and the general file.

The numerical filing system is the most satisfactory in an establishment having a central filing department because it facilitates the file clerk's recording the withdrawal of the correspondence between any firm or individual by merely entering against the party withdrawing the correspondence the number of the file holder and the date.

Fig. 41 shows the file clerk's numerically arranged card record. This card record gives the name of the firm or individual, whose correspondence is in the folder of a certain number, together with the exact address of the party or firm and the dates of all correspondence, as well as date and number of transfer when the folder becomes too bulky or is so obsolete that it should be transferred to a storage file.

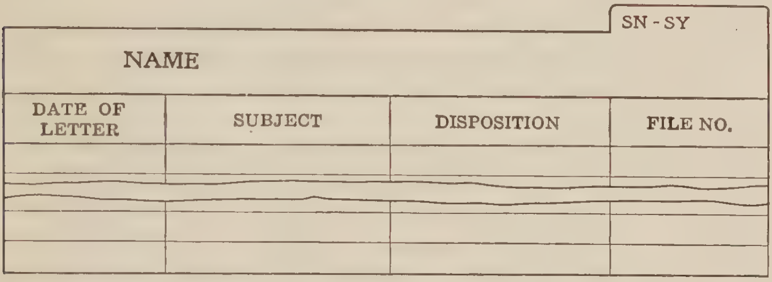
The alphabetically arranged cross-index or finding card is shown in Fig. 42. This enables one to find the number of the folder in which the correspondence with any individual or firm is filed. Fig. 43 shows the little slip which the file clerk writes when he hands out any file folder. When the folder is returned, he may either destroy the slip or hand it to the party who made the withdrawal as a receipt for the return of the folder. The folders are most generally kept in "vertical" filing cases, and their contents are retired to transfer storage cases according to some definite rule. For instance, it may be decided that at the beginning of each month the correspondence of the corresponding month of the previous year shall be retired from the current file. As correspondence is apt to fall out of folders that are carried about a good deal, it may be found desirable to use stout roomy envelopes instead of the open folders. In order to keep down the

NAME					FILE No.	
ADDRESS						
DATES OF LETTERS	DATES OF REPLIES	DATES OF LETTERS	DATES OF REPLIES	DATES OF LETTERS	DATES OF REPLIES	DATE AND NO. OF TRANSFER

Fig. 41.—Numerically arranged card record showing contents which should be in folder of a given number, together with dates of transfer to storage. White card, 6 inches wide, 4 inches high.

expense of preparing a folder and indexing letters from transient correspondents the alphabetical system of filing may be applied to all new names until at least three or more letters and replies have been received.

In order to prevent correspondence becoming disarranged the folder may be punched, and the letters also punched and fastened to the folder by McGill fasteners. The letter bearing latest date should always be filed on top. Different departments or bureaus may advantageously be provided with file folders of different distinctive colors.



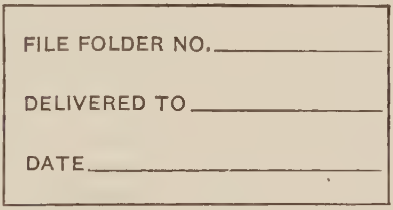
SN - SY

NAME

DATE OF LETTER	SUBJECT	DISPOSITION	FILE NO.

Fig. 42.—Alphabetically arranged cross-index or finding card for finding the number of the folder in which correspondence is located. White card, 6 inches wide, 4 inches high.

Carbon copies of letters for filing purposes should be written on buff, lemon or canary-colored paper, instead of on the thin white sheets usually used for this purpose. The yellow color immediately calls attention to the fact that it is a copy of an outgoing letter. The thin sheets of poor quality usually used have the disadvantage of not standing alone, of folding, wrinkling or tearing easily, and not being as easily recognized as copies of outgoing correspondence as those on yellow paper.



FILE FOLDER NO.____________

DELIVERED TO ____________

DATE____________

Fig. 43.—File clerk's record of withdrawal of folders by various departments or individuals. When folder is returned this slip may be handed out as a receipt. White paper, 5 inches wide, 3 inches high.

In certain lines of business it is important to have a copy of the signature of the person signing letters. Where such is the case the roller press copy will be preferable to carbons. As an additional precaution, the press copy bound book may be used for a second copy besides the roller copy.

150. Relative Location of Offices.—Where a local telephone exchange is in use, the telephone operator can be placed so as to receive all persons making calls. One of the most serious defects where this system is in force is the failure to provide suitable waiting or reception rooms for callers. In many cases well-to-do establishments provide a single bench in a very small place, making it necessary for all sorts and conditions of callers to be crowded into cramped quarters. A separate calling place should be provided for all applicants for factory employment, and such applicants should be promptly directed to that place by the telephone operator or reception clerk. For other callers a neat room provided with the company's publicity matter does much to secure their good-will.

It is apparent that the general office, and especially the filing department, must be centrally located. Those department offices should be located nearest the reception room, whose managers are most likely to receive a considerable number of business callers. Such offices would be those of the purchasing agent, the sales manager, and the cashier. The designing of a set of offices or of an administration building deserves careful attention, and a good plan to pursue in planning new offices is to cut out templets representing each desk and piece of furniture and to place these into trial positions, and then to cut out templets representing the various offices, placing those offices together which are likely to have the greatest inter-communication. Partitions between offices should be low for the sake of good ventilation, with cathedral glass or similar translucent glass in the upper portion, and with the name of the department plainly lettered on the door. It is preferable to erect partitions in sections so that they may be easily removable.

151. Desks.—Some executives prefer to use flat-top desks so that all papers are certain to be put into their proper files, rather than getting into pigeon-holes. The putting of flat-top desks in a position where the occupants must face each other, or the using of double flat-top desks, is apt to be annoying to the persons occupying them, as privacy and concentrated thought are interfered with by having to look constantly at another person, and perhaps being drawn into conversation that would best be omitted.

However, it must be borne in mind that wall space can be as a rule better utilized as a back to filing devices than as a back to desks, and with some ingenuity desks can be placed in such positions that they are not against walls, and also so that the occupants of desks are not facing one another.

Of recent years types of desks have come into use in which the old-style storage drawers have been replaced by vertical files and card-index drawers All drawers containing company business should be accessible at all times to department heads. Personal storage drawers should be so marked on the outside, and to these drawers the desk occupant may be given a private key. It is desirable to keep the private offices of the more important officials and department heads free from files, the secretary or stenographer bringing in and removing all papers required. The table on which such papers are put during discussion or dictation should be separate from the official's desk.

The sales department is not here considered a part of the general office. Hence no mention is made here of follow-up and other systems in connection with sales, since we are confining ourselves to the functions of the general office in so far as they affect the factory administration.

CHAPTER XI

THE ORDER DEPARTMENT

152. Functions of Order Department.—The order is the starting point of activity in the factory. It is the basic authority upon which is built the entire structure of cost statistics. There must be a regular routine for the proper authorization, classification, and record of all orders issued, and for the dissection of such general orders as require it into the sub-orders or individual operation instructions which form an essential part of an accurate factory system. This dissection into elemental steps is, however, beyond the immediate control of the order department, and is a function of the production department, whose duties are distinct from and additional to those of an order clerk or order department. The order department's sphere is limited to the issuing of general orders, and turning them over to such departments as must execute the work, such as the production department, the shipping department, etc. It is the duty of the order department to properly classify all orders, and to determine from time to time the progress of orders issued. This last process may in some cases be well delegated to a distinct department known as the order tracing department, whose duty it will be to consult with the production department and such other departments as may be necessary, and collect such data as are necessary to a definite periodical report of the condition of every order in the factory. In some cases the order clerk may act as tracer himself so far as customers' orders are concerned, provided this does not interfere with his accounting or statistical duties, or the function may be assigned to some particular individual. This man's duties are distinct from those of the production department's tracer, whose duty it is to follow up the progress of individual parts. For instance, in an automobile factory the order department's tracer would follow up John Smith's order for a car having a special reduction gear, special springs, special battery box, and special body, while it would be the particular function of the production department's tracer to determine what parts need overtime work to get out the transmissions on time for Shop Order D. 5100 calling for twenty-five cars.

Naturally the owners of the business or their most direct representatives will be the initiating authority in the issuing of general orders, based either on customers' orders or on the providing of a stock on hand of the manufactured product. The filing of all orders received, and their proper classification, is a function by itself, to be assigned to an order clerk or order department. The departmental laying out of the working system of a factory must not be construed as meaning a distinct office, or many clerks as belonging to what is called a "department." A department may consist of but one man, or one man may carry several departments. In small establishments it is just as important as in large ones that the distinct departmental duties of every man be definitely laid down. The place and relations of the man and the department in the staff organization, and of the records, statistics, and accounts, must be made perfectly clear, preferably in a graphically charted manner, as referred to elsewhere in this work.

The order department will necessarily have more work in an establishment receiving numerous small orders for a variety of product than in one making a limited range of a standard product sold in quantity.

153. Classification of Orders.—It is sometimes found advantageous for the clerk or department receiving and recording customers' orders to have a strictly consecutive record of all customers' orders arranged in order of seniority, irrespective of classification, according to what the orders call for, giving the orders a record number in addition to any class letters or numbers which may be assigned them subsequently by the production department.

The most satisfactory arrangement of orders is one in which all work of the same general class is put together into a series by itself.

The orders belonging to each series are best written on cards or loose leaves to be filed in some modern binding device, permitting of the easy insertion or taking out of any leaf, and provided with a lock so that only authorized persons may make such removals or insertions.

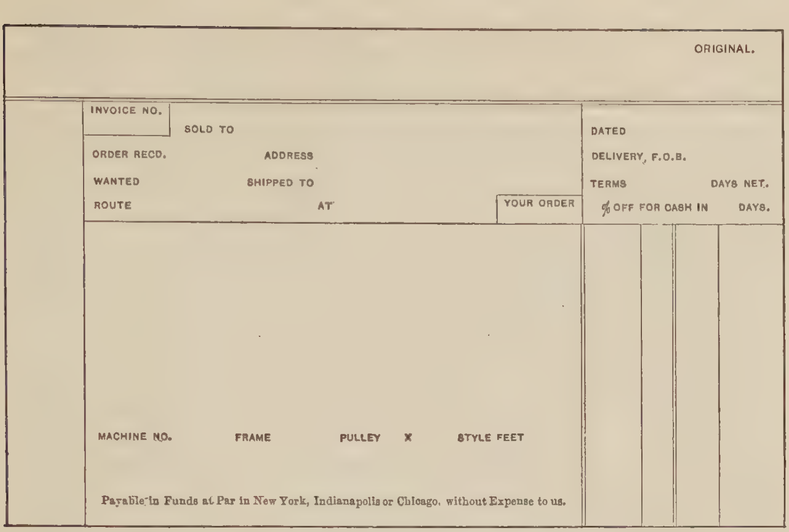
154. Manifold Copies of Orders.—The book typewriter, also known as the billing machine or flat-bed machine, is almost indispensable in the rapid duplication of cards or loose leaves involving tabulation, with as many carbon copies as may be needed. It will be necessary that a set of copies of orders be provided the production department. A set of copies may also be required respectively by the superintendent and the works manager or such corporation officer as devotes his particular attention to the internal working of the factory.

The cards or sheets representing live or uncompleted orders are of course kept in a group by themselves, distinct from the files of dead or completed orders.

It is advisable to have each distinct order series printed on paper of a distinct color. The order department will index by customers' names, and, if desirable, by styles and sizes of product, the orders in each series.

155. Example of Order Series.—As an illustration of the grouping into series, "A" orders will call for complete product items which have to be built to order; "B" orders for repair parts which have to be built, and "C" orders for any apparatus which can be shipped immediately out of stock. These three classes of orders will generally be all that are needed to classify customers' or agents' orders. The issuing, filing, and tracing of these classes come properly under the head of an order department, which should be distinct from the factory production department. This order department issues all of its orders or instructions to the production or planning department. The latter department must be the point of centralization, or clearing-house of all orders to do work in the factory proper.

As an example of the form of orders issued by an order department, the following examples are given, representing a combined invoice and shipping order with manifolds serving various purposes, as used by a company manufacturing electrical dynamos and motors. The set of forms shown are used only for complete machines, a separate series being used for supply or repair orders. One distinct order is used for each distinct machine. In this way invoices are promptly mailed for partial shipments where a customer orders more than one machine. Fig. 44 shows the form which serves for original order, and also for invoice by the billing department. There are two additional forms identical with this original, excepting that they bear in the upper right-hand corner in heavy type the notations, respectively, "Duplicate Invoice," and "For Shipping Department Duplicate File."



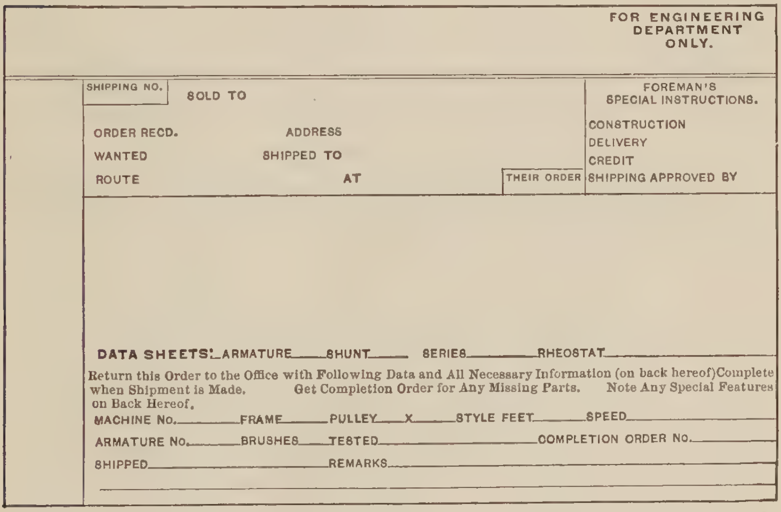
ORIGINAL.

INVOICE NO.
SOLD TO
DATED
ORDER RECD. ADDRESS
DELIVERY, F.O.B.
WANTED SHIPPED TO
TERMS DAYS NET.
ROUTE AT
YOUR ORDER
% OFF FOR CASH IN DAYS.

MACHINE NO. FRAME PULLEY X STYLE FEET

Payable in Funds at Par in New York, Indianapolis or Chicago, without Expense to us.

FIG. 44.—Example of manifold order, one copy serving as original invoice, one copy as duplicate invoice, and one copy as shipping record. Additional manifolds with slightly different typesetting, and serving further purposes, are shown in succeeding figures. Light blue bond paper, 9 inches wide, 6 inches high, ruled in red.



FOR ENGINEERING DEPARTMENT ONLY.

SHIPPING NO.
SOLD TO
FOREMAN'S SPECIAL INSTRUCTIONS.
ORDER RECD. ADDRESS
CONSTRUCTION
DELIVERY
WANTED SHIPPED TO
CREDIT
ROUTE AT
THEIR ORDER
SHIPPING APPROVED BY

DATA SHEETS: ARMATURE____ SHUNT____ SERIES____ RHEOSTAT____

Return this Order to the Office with Following Data and All Necessary Information (on back hereof) Complete when Shipment is Made. Get Completion Order for Any Missing Parts. Note Any Special Features on Back Hereof.

MACHINE No.____ FRAME____ PULLEY____ X____ STYLE FEET____ SPEED____

ARMATURE No.____ BRUSHES____ TESTED____ COMPLETION ORDER NO.____

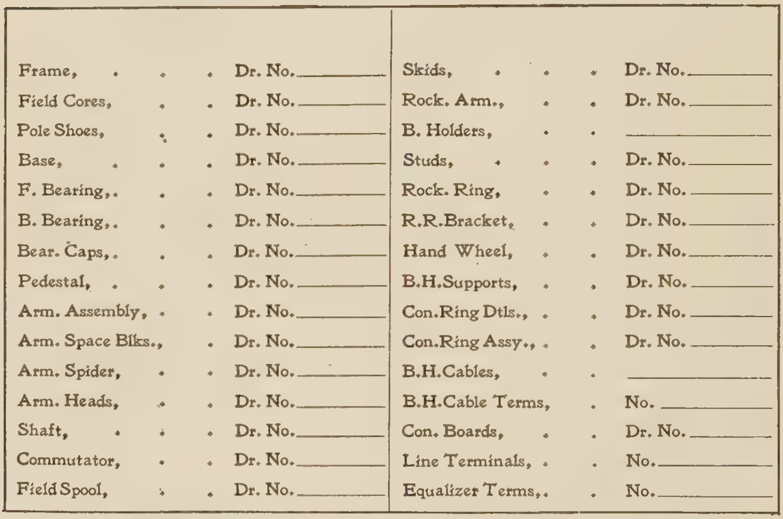
SHIPPED____ REMARKS____

FIG. 45.—Fourth copy of manifold order. A number of similar manifolds go to various shop departments. White bond paper, 9 inches wide, 6 inches high.

Fig. 45 shows the fourth copy, which is marked, "For Engineering Department Only," and contains same items as original, omitting accounting department's financial memoranda, and adding technical memoranda. The reverse of this copy is a drawing list, and is shown in Fig. 46.

The fifth copy is the same as the fourth, excepting that it is marked "For Shop Only." Its reverse is the same as the reverse of the fourth copy.

While the particular company using the order form illustrated preferred to use a separate sheet for every machine, such a procedure is not at all necessary. Order and invoice may be simultaneously written on a flat-bed typewriter, there being two columns, one column for items ordered, another column for items shipped. When the first partial shipment is made, entries are made into the column headed "Items Shipped," and one copy of the several which are simultaneously written is used as an invoice, and shows the exact status of the order to the customer. The unshipped items are then transferred by being copied to a new set of blanks upon which entries are made as soon as the second partial shipment has been made. It is customary to have



Frame,	Dr. No.	Skids,	Dr. No.
Field Cores,	Dr. No.	Rock. Arm.,	Dr. No.
Pole Shoes,	Dr. No.	B. Holders,	
Base,	Dr. No.	Studs,	Dr. No.
F. Bearing,.	Dr. No.	Rock. Ring,	Dr. No.
B. Bearing,.	Dr. No.	R.R.Bracket,	Dr. No.
Bear. Caps,.	Dr. No.	Hand Wheel,	Dr. No.
Pedestal,	Dr. No.	B.H.Supports,	Dr. No.
Arm. Assembly,	Dr. No.	Con.Ring Dtls.,	Dr. No.
Arm. Space Blks.,	Dr. No.	Con.Ring Assy.,	Dr. No.
Arm. Spider,	Dr. No.	B.H.Cables,	
Arm. Heads,	Dr. No.	B.H.Cable Terms,	No.
Shaft,	Dr. No.	Con. Boards,	Dr. No.
Commutator,	Dr. No.	Line Terminals,	No.
Field Spool,	Dr. No.	Equalizer Terms,.	No.

FIG. 46.—Reverse of No. 4 and succeeding copies of manifold order giving data for engineering department and various shop departments. Light blue bond paper, 9 inches wide, 6 inches high.

an invoice mailed at the time a shipment is made, even if such shipment is but partial.

The order system of an establishment which makes up goods in quantity for stock, of which it carries a considerable variety, will be quite different from the order system that would be best for an engineering works.

A form in such a case would have spaces for the name of the customer, his address, the railroad or express company by which to ship. This sheet is filled out by the salesman when he takes the order, with the foregoing items, and also the proper items opposite salesman's name, date sold, terms, quantity, list number, article, and price. On its receipt at the company's office the order is given a number, and is properly indexed or registered. Proper acknowledgment of the order is then made; it next goes to the credit department; thence to the warehouse department, where each item is signed by the individual putting up that item; it is then inspected, and receives the inspector's check; the goods are next packed and the order is checked by the shipper; it next goes to the billing department, and the billing clerk puts his check after the words, "Billed by"; it is next examined and rechecked for corrections of prices, extensions, etc., and signed opposite the words, "Examined by," and is now ready to go to the bookkeeper, who fills in the ledger folio.

Mail orders, and orders brought in directly by customers, are transcribed on to the regular order form as described.

In this type of business salesmen's records may be made up from order copies.

In cases where it is desirable to keep a careful time-check on each event in the handling of orders, a time-stamp may be used to advantage, space being left on the order blank for all such time-stamps which should appear on any one copy.

Where the billing machine is used for writing out the order, a large number of other forms may be made at the same writing, the bunch or pad of forms being stitched at the left-hand margin, and each form printed on a different color of paper. At one writing, for instance, we may have order, original, and duplicate invoice, statement, memorandum of draft, posting record, shipping clerk's record, cost department's record, various shop department copies, and acknowledgment to customer.

156. Instructions as to Order System.—Below is given a sample of instructions regarding classification of shop orders, which it is desirable to issue at the time of inaugurating a classified order system:

> All orders emanating from the office will pass through the production department office before being distributed in the shop. The production department is responsible for the proper distribution, tracing and following up of all orders as to location and condition. Before distributing orders, production department has shop superintendent note orders, securing his initials or those of his assistant, cut with conductor's punch, punched through all copies.
>
> As regards the classification of orders inside the shop, these are as follows:
>
> General series, without letter prefix, covering new parts for standard machines. Manila-colored tag.
>
> "A" series, covering repair or other parts called for by shipping orders and requiring work in the shop, bearing different serial numbers from the general series and yellow tracing tag.
>
> "B" series (tool-room series), covering new tools, jig, dies, and other tools made in the shop. Record book kept by foreman of tool department, bearing superintendent's "O. K." after each order in book. Tool-room foreman sends book daily to production department, to have proper tags and orders written. Tool-room foreman keeps stub of tag on file till work is completed, entering on stub list of material used, and sending same, when work is completed, to production department. Salmon tag.
>
> "C" series—patterns. Orders and tags issued by production department on receipt of request for order from department foreman. Green tag.
>
> "D" series—plant additions, including fixtures. Blue tags issued on authorization of works manager.
>
> Standing non-productive orders. See separate sheet for detailed list of these orders. Special tags headed Standing "Non-productive Order."

In many classes of business the furnishing of repair parts is an important feature of the business, so that the order department may need to be divided into two sub-departments or two distinct departments, such as the contract department and the supply or repair department. The latter department will then handle all correspondence in regard to supply orders, stamping the original customer's order with a time-stamp indicating date received, when and by whom approved for credit, supply order number, when order written, by whom checked, and when and by whom acknowledged.

The head of the supply department must be well enough versed in the details of the business to edit the original orders, *i.e.*, he must see that the items ordered by the customer are inserted in correct form for clear understanding by all in the factory who are to handle the order. A single item asked for by the customer may require the collection or manufacture of a number of component parts or items; in such cases a detailed list of component items will be made out on the supply department order by the head of that department.

The supply order will have to be written in manifold similar to a regular or contract order. As an instance of how many copies will be required the following typical case will serve to illustrate:

(1) One original copy. This goes to billing clerk as soon as order is written.

(2) One yellow copy to be held in supply department until goods are ready for shipment of either part or all. It is then sent to shipping department, which sends it to billing clerk when shipment of either part or all is made. In case of partial shipment, billing department sends the yellow copy back to supply department, where it goes through the same routine as before until shipment is completed.

(3) One blue copy. This goes to stores record department. Stores record department marks with small rubber stamp, "In stock," all items regularly carried in stock, and "To be taken from Stock Order No. . . . . . ." all items which are regular stock, but of which there is not a supply in the stock-room.

(4) One fawn copy for stock-room. Head storekeeper of finished parts will get out all parts which are ready to ship, checking same off his copy of the supply order, keeping the unfilled copies on one file board, the partially filled ones on another, and filing away the completely filled ones.

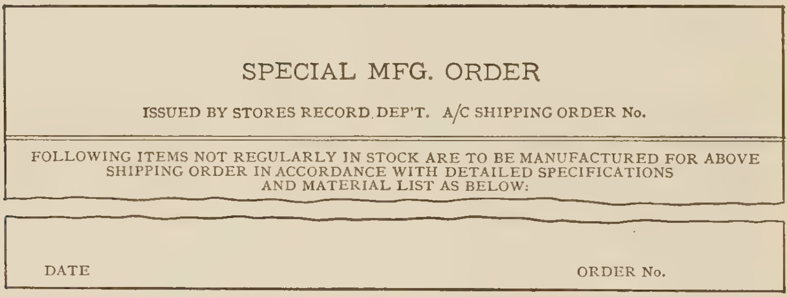
Head attendant in finished parts storeroom puts the items for any one shipment into a bin by themselves. When he has all items in the bin which he can get, he designates this by putting a tag marked "Complete," or "Partial," into the bin, together with a tag bearing the order number. Some one regularly delegated from the supply department calls several times a day to see these bins, taking with him the supply department's file board of all yellow copies of supply orders, and leaving with shipping department the copies of orders for which goods are ready for either entire or partial shipment. However, head storeroom attendant will not depend on these personal calls from supply department as the only means of advising that goods are ready for shipment, but will send a daily report to supply department of all orders ready for complete and for partial shipment.

Supply department decides whether or not partial shipment is to be made at once, and attends to any correspondence with customer which is necessitated by inability to ship entire order.

(5) One pink copy of order for a continuous numerical file in supply department for reference.

(6) One white copy for continuous numerical file in contract order department, which needs sometimes to know about customers' supply orders. This can be included or omitted as the conditions of the business may demand.

157. Special Orders.—For all items not regularly carried, the stores record department writes a request on production department to issue "Special Manufacturing Order," covering such parts as have to be specially made.



SPECIAL MFG. ORDER

ISSUED BY STORES RECORD DEP'T. A/C SHIPPING ORDER No.

FOLLOWING ITEMS NOT REGULARLY IN STOCK ARE TO BE MANUFACTURED FOR ABOVE SHIPPING ORDER IN ACCORDANCE WITH DETAILED SPECIFICATIONS AND MATERIAL LIST AS BELOW:

DATE ORDER No.

Fig. 47.—Form of "special manufacturing order" which selects from a shipping or supply order only those items which have to be made in the shop especially for this shipping order. It omits all items with which the shop is not concerned and bears the same number as the complete shipping order. Salmon colored bond paper, 8 1/2 inches wide, 7 inches high.

The stores record department will also issue requisitions on the purchasing department for any items which have to be purchased on the supply order. The castings record clerk of the department will put in the requisition for any castings required, and the head of the stores record department will put in the requisition for other purchased items.

Fig. 47 shows the general form for the "Special Manufacturing Order," which is a sub-order bearing same number as the supply order on whose account it is issued. One copy of each "Special Manufacturing Order" is sent to stock-room.

A form is also used for notifying the production department to hurry through stock orders covering any parts regularly stock parts, for which there is a stock order in the shop, but no pieces in the stock-room.

All the above details are attended to by the stores record department.

158. Changes in Orders.—Changes in orders should be written out on regular order forms, bearing same number as original order, with the word "Change" printed diagonally across the form in large, open-skeleton type of red color. They are then filed with the original order by all departments receiving same.

The above outline covers the duties which should be assigned to an order department or order clerk and a supply department. The detailed issuing of the sub-orders which are necessitated by the issuing of a general or main order for complete machines, and the following up of such orders, are matters described in detail in subsequent chapters.

REFERENCE

Cook: "Factory Management," Chapter VII.

CHAPTER XII

BILLS OF MATERIAL

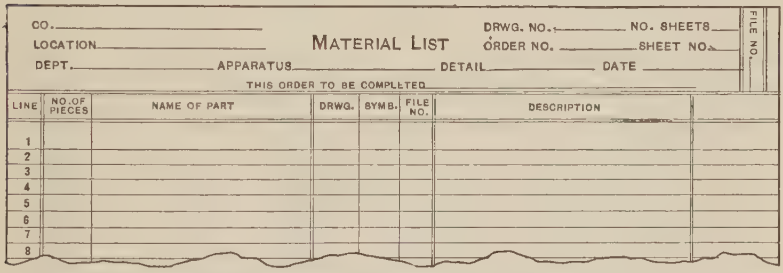
159. Bill of Material Defined.—The bill of material for a manufactured product, whether that product be a machine or a piece of furniture, is a list of all the individual component pieces which, when properly put together, constitute the finished article.

In an establishment which makes to order many different machines or complex articles, the preparation of bills of material is a far more extensive work than in factories making but few different types of product and shipping from stock. In either of the above-mentioned classes of product, however, the purchasing of the necessary raw materials and manufactured purchased parts, as well as all the manufacturing processes, are greatly simplified and facilitated by the prompt preparation of accurate and complete bills of material for the use of all departments which need to know fully and exactly all the component parts of the finished product.

160. Grouping of Parts.—The bill of material or list of parts, in order to be most useful in various departments, needs sometimes to be arranged in various ways. For instance, for most convenient use in the purchasing department the list is best arranged according to classes of material, the steel castings being listed in one group, the iron castings in another group, brass castings in another, bar stock in another, etc. For the production department, if it has its stock records arranged by mark numbers of individual pieces, the list may more advantageously be arranged according to mark numbers. For the various shop departments, a bill arranged according to sequence of building of the various assembly and sub-assembly groups will be most satisfactory to work from. The last type of bill of material is the arrangement most generally in use if but one arrangement is to be followed.

The bill of material must be specific and complete in regard to dimensions and materials if these points are not covered by a drawing specified in the bill. It is necessary that the man in charge of making bills of material have a full knowledge of the exact materials that are required in each case. He needs also to know what materials are standard commercial articles, and what sizes and dimensions, are most commonly in stock in the general market. It is important that the head of the bill of material department be a man whose opinion will be respected by the drafting and designing departments, so that he may be free to make requests for modifications of the items specified by draftsmen and designers in order to secure conformity with commercial practice or to the standards already in use in the particular establishment in which he is employed.

161. Special Parts.—It is very desirable that the stores department furnish the engineering and drafting and bill of material departments from time to time lists of unused special castings, large shafts, large forgings, etc., which might possibly be specified in bills of material as substitutes in place of new purchases or new designs. In many an establishment there will be found parts in stock which it is desirable to adapt for use for a particular job, and which can be used without in any way interfering with standardization. Card records covering any such items will be found useful, and when the items are allotted they are marked off the cards. In order to make this system of using up special parts easily workable, it is advisable to mention on the card the location of the item in the buildings or yards. A symbol or number may also be painted on the piece and recorded on the card. A sketch showing any special features may also be shown on the card record, also any defects. It may be advisable to use a separate card for each separate piece if the pieces are large and special.



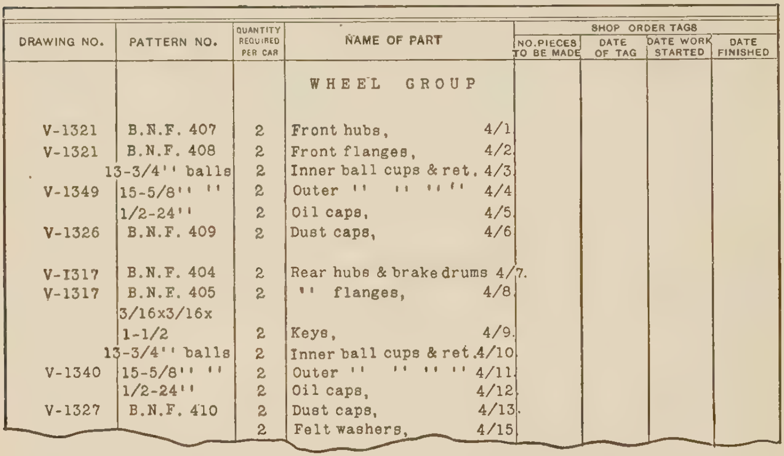
CO.
LOCATION
DEPT.
MATERIAL LIST
APPARATUS
DRWG. NO.
ORDER NO.
DETAIL
NO. SHEETS
SHEET NO.
DATE
THIS ORDER TO BE COMPLETED
FILE NO.

LINE	NO. OF PIECES	NAME OF PART	DRWG.	SYMB.	FILE NO.	DESCRIPTION	
1							
2							
3							
4							
5							
6							
7							
8							

FIG. 48.—Simplest form for material list. White bond paper, 8 1/2 inches wide, 11 inches high, red and blue ruling.

Fig. 48 shows a typical form for bill of material. The first column is merely a consecutive numbering of the lines and affords a concise system of reference to any items in the bill.

162. Departmental Bills of Material.—Where a factory is divided into departments whose work is quite independent of each other, it may be found advisable to issue separate material lists for each department, such departmental list covering only such items as the department in question needs to be advised of. For instance, there may be distinct and different bills prepared respectively for the pattern department, the group assembly department, and the erecting department, each of these separate bills of material covering only such items as are needed for the complete information of the department in question, in order that the work in that department may be correctly done.

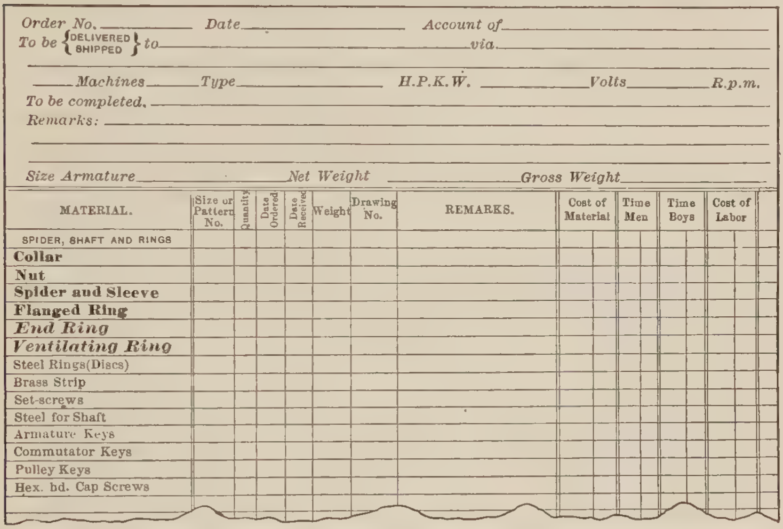


DRAWING NO.	PATTERN NO.	QUANTITY REQUIRED PER CAR	NAME OF PART	SHOP ORDER TAGS			
				NO. PIECES TO BE MADE	DATE OF TAG	DATE WORK STARTED	DATE FINISHED
			WHEEL GROUP				
V-1321	B.N.F. 407	2	Front hubs, 4/1				
V-1321	B.N.F. 408	2	Front flanges, 4/2				
	13-3/4'' balls	2	Inner ball cups & ret. 4/3				
V-1349	15-5/8'' ''	2	Outer '' '' '' '' 4/4				
	1/2-24''	2	Oil caps, 4/5				
V-1326	B.N.F. 409	2	Dust caps, 4/6				
V-I317	B.N.F. 404	2	Rear hubs & brake drums 4/7.				
V-1317	B.N.F. 405	2	'' flanges, 4/8				
	3/16x3/16x 1-1/2	2	Keys, 4/9.				
	13-3/4'' balls	2	Inner ball cups & ret. 4/10				
V-1340	15-5/8'' ''	2	Outer '' '' '' '' 4/11				
	1/2-24''	2	Oil caps, 4/12				
V-1327	B.N.F. 410	2	Dust caps, 4/13				
		2	Felt washers, 4/15				

FIG. 49.—Bill of material as used in automobile work, dividing the machine into groups and designating each part by a symbol indicating the group into which it belongs and the number of parts in each group. White bond paper, 8 1/2 inches wide, 11 inches high.

163. Assembly Groups.—Fig. 49 shows a bill of material in which the parts are arranged by groups as used in automobile manufacturing. In this list it will be noted that a further identification or mark number is mentioned immediately following the name of the part. For instance, the front hubs, in addition to being identified by the drawing number and the pattern number, are known as 4/1, meaning Part No. 1 in Group 4 of this type of car.

A similar bill of material in which the parts are arranged by assembly groups, as used in a dynamo and motor factory, is shown in Fig. 50. In this bill an attempt was made to designate materials by different styles of type, the heavy block type signifying cast iron, the heavy italics specifying cast brass, and the light type signifying articles made of bar stock or purchased. This plan is as a rule not satisfactory, however, as it may be desirable in special instances to use steel castings instead of cast iron, bronze or malleable iron in the place of brass, nickel steel in place of machinery steel, etc., and it is simpler to leave a column for material to be filled in in each particular bill of material.



Order No. ______ *Date* ______ *Account of* ______
To be {DELIVERED / SHIPPED} *to* ______ *via* ______

______ *Machines* ______ *Type* ______ *H.P.K.W.* ______ *Volts* ______ *R.p.m.*
To be completed. ______
Remarks: ______

Size Armature ______ *Net Weight* ______ *Gross Weight* ______

MATERIAL.	Size or Pattern No.	Quantity	Date Ordered	Date Received	Weight	Drawing No.	REMARKS.	Cost of Material	Time Men	Time Boys	Cost of Labor	
SPIDER, SHAFT AND RINGS												
Collar												
Nut												
Spider and Sleeve												
Flanged Ring												
End Ring												
Ventilating Ring												
Steel Rings(Discs)												
Brass Strip												
Set-screws												
Steel for Shaft												
Armature Keys												
Commutator Keys												
Pulley Keys												
Hex. bd. Cap Screws												

FIG. 50.—Bill of material as applied to dynamo and motor manufacture. Components arranged by groups, tracing and cost record columns on same sheet with list of parts. White bond paper, 8 1/2 inches wide, 11 inches high.

164. Bill of Material as Tracing or Cost Record.—The last two examples of bills of materials also contain columns for use in tracing or following up purchases or manufacture of material in the shop, and in the last example, columns for figuring costs of the separate parts. As a general rule it is undesirable to make the bill of material fill so many different purposes, as it crowds too much into a small space and confuses departments who have no interest in the following up or figuring of costs. It will generally be found desirable to have separate forms printed for use by the cost department, the tracing department, and any other departments that might have to use the bill of material in connection with their work, such forms being printed on sheets of such size that they may be bound in with sheets of material, and opposite the respective sheets listing the material items. (See Figs. 92 and 152 as examples of such insert sheets.)

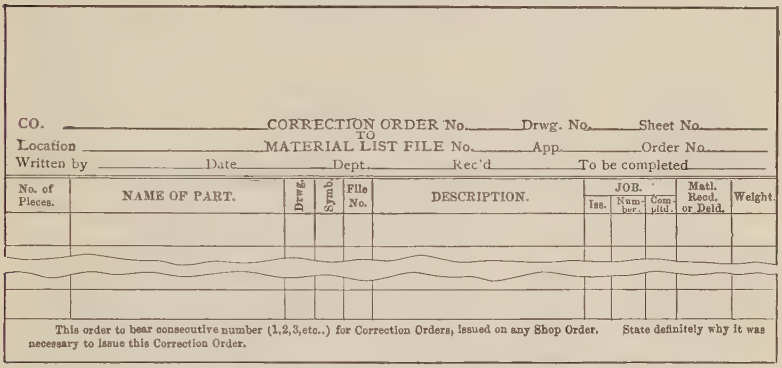
165. Changes in Bills of Material.—One of the most vexing problems in manufacturing is that of changes or corrections in bills of material. It is seldom that a machine or any apparatus consisting of a considerable number of parts is completely and correctly described in the first bill of material, because as a rule it is necessary to get the apparatus started and some of the leading items ordered in the shop or outside before the entire bill can be completely checked and crystallized. Changes in the way of insertion of omissions do not usually cause much inconvenience or loss provided they are not allowed to pass unnoticed until the order is well under way. The type of alteration that does cause loss almost invariably is a change in design inaugurated after a bill of material has been sent out into the shop and work started. This type of change should be most carefully guarded against. It is easy for a designing department to get into the bad habit of making changes after work has been started. The persistence in this practice of making changes in this way may be a matter of sufficient seriousness to ruin a manufacturing establishment. Not only does this practice entail enormously increased costs of manufacture, but it results in so many different types of machines being sold that the supplying of repair parts becomes a most complicated problem, necessitating the most careful and complete records of each machine sold, and either the carrying of an enormous variety of repair parts, or else making the customer wait for a long time for a repair part when he has a break-down, and making the part cost him so much on account of its being made as a single piece that he becomes dissatisfied with the delay and high price.

One way of recording alterations is to issue a separate sheet of the bill of material for each set of alterations. A form for use with this method is shown in Fig. 51.

In case this method is used, it is necessary to draw a line through the changed item or inter-line for omitted items, and make small notes referring to the alteration-sheet.

Another way of recording changes is by binding the bill of material in a cover of plain tough manila paper, and entering on inside of cover a rubber stamp every time a change is made, such rubber stamp bearing the date the change was made and any other necessary data, and then entering a reference to the rubber stamp impression covering the correction or omission in its proper place on the original bill of material by inter-lining.

In case it is necessary to recall bills of material from various departments for the purpose of entering changes, such recalling must be done in a systematic manner with the full knowledge of the departments from which the bills are recalled. A system of receipts may be desirable for this purpose, and a department should be permitted to finish any entries that may be in process of being made at the time the bill is recalled before the bill is taken away from that department.



CO. ____ CORRECTION ORDER No.____ Drwg. No.____ Sheet No.____
TO
Location ____ MATERIAL LIST FILE No.____ App.____ Order No.____
Written by ____ Date____ Dept.____ Rec'd____ To be completed____

No. of Pieces.	NAME OF PART.	Drwg.	Symb.	File No.	DESCRIPTION.	JOB.			Matl. Recd. or Deld.	Weight.
						Iss.	Number.	Compltd.		

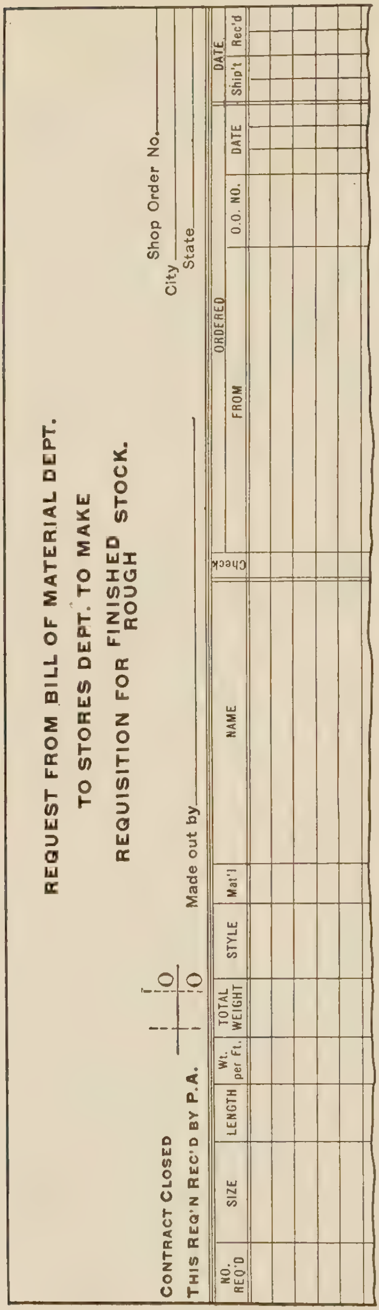
This order to bear consecutive number (1,2,3,etc..) for Correction Orders, issued on any Shop Order. State definitely why it was necessary to issue this Correction Order.

FIG. 51.—Correction sheet for bill of material. White bond paper, 10 inches wide, 9 inches high, ruled in red and blue.

166. Getting Work Started before Completion of Bill of Material.—The preparation of a complete bill of material may be a matter requiring several days, and perhaps several weeks. In the latter case it may be desirable to get some of the work under way before the bill of material can be completed as a whole. This would be particularly likely in the case of purchased items, which require prompt ordering so as to save every possible day of time. For this reason it may be desirable to have the head of the bill of material department initiate the ordering of such items by having him make out a list of these items on a sheet which constitutes a request for the immediate issuing of requisitions for same, proper notations being made on the bill of material that such requests for requisitions were made. This in order to prevent the duplication of purchase orders for these items. If the head of the stores department is the person who regularly orders all materials, then the procedure takes the form of a request on the head of the stores department to make requisitions on the purchasing agent for the items in question.

Fig. 52 shows a form used in this manner in order to expedite the ordering of necessary materials before the completed bill of material is issued.

The head of the stores department should have a system of annotating the various items in the bill of material so as to designate what disposition he has made of them, such as ordering the necessary material or withdrawing the items from finished stock on hand, etc. As before stated, it is preferable to provide separate sheets for keeping these annotations referring to stores and stock records, production department records, tracing records, etc., such sheets being of dimensions easily bound in with a copy of the bill of material.



REQUEST FROM BILL OF MATERIAL DEPT.
TO STORES DEPT. TO MAKE
REQUISITION FOR FINISHED / ROUGH STOCK.

Shop Order No.______
CONTRACT CLOSED ______ City ______
THIS REQ'N REC'D BY P.A. ______ Made out by ______ State ______

NO. REQ'D	SIZE	LENGTH	Wt. per Ft.	TOTAL WEIGHT	STYLE	Mat'l	NAME	Check	ORDERED			DATE	
									FROM	O.O. NO.	DATE	Ship't	Rec'd

Fig. 52.—Advance request for purchase requisition made pending preparation of complete bill of material. Yellow bond paper, 10 inches wide, 9 inches high, ruled in red and blue.

CHAPTER XIII

THE DRAFTING DEPARTMENT

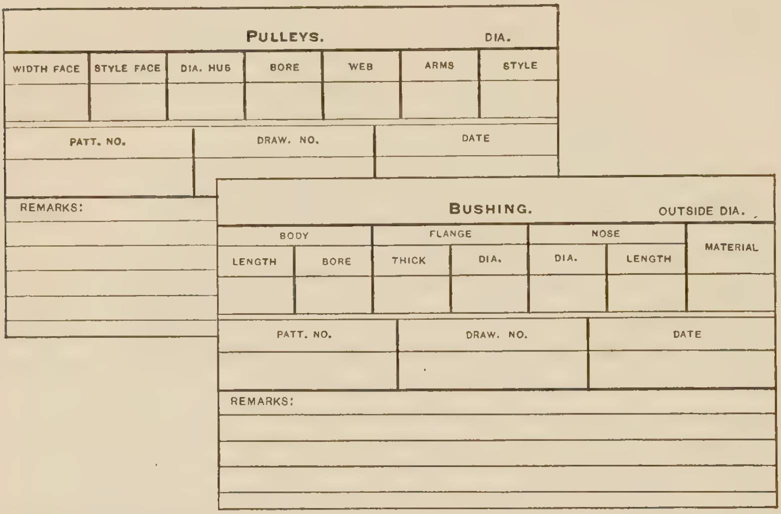
167. Functions of Drafting Department.—The drafting department usually includes the designing department in most manufacturing establishments, excepting in a few large concerns where the designing is done by a separate department which furnishes sketches and the results of calculations to the drafting department.

The work of the drafting department will usually be divided into such work as designing, drawing, tracing, blue-printing, indexing, and filing. The designing of tools or the making of tool drawings in accordance with the sketches or instructions of the head of the tool-making department may constitute another subdivision of the drafting department.

168. Numbering Parts.—It is generally desirable to designate all parts by "mark number" or "part number." This system necessitates the keeping of a consecutive number record of parts, in which is given a brief definition of the piece together with reference to the drawing number, and the pattern number if there is a pattern. There should also be a consecutively numbered pattern record in which is given also a definition of the piece, the drawing number, and the mark or part number. In order to avoid duplication of drawings and of patterns, and also in order to avoid giving different mark numbers to the same purchased finished parts, such as bolts, screws, etc., there must be an alphabetically arranged record of concrete names of parts in which may be found the corresponding mark numbers and pattern numbers.

Most drawing rooms give no attention to indexing as above suggested. The natural result of this neglect is that the same part is drawn over and over again, and that separate patterns are made for parts for which some existing pattern could have been used.

169. Standardization of Parts.—There is hardly a machine of any kind in which there will not be found certain details which recur again and again in similar forms on other machines. If a draftsman follows the whim or inspiration of the moment he is



PULLEYS. DIA.

WIDTH FACE	STYLE FACE	DIA. HUB	BORE	WEB	ARMS	STYLE

PATT. NO.	DRAW. NO.	DATE

REMARKS:

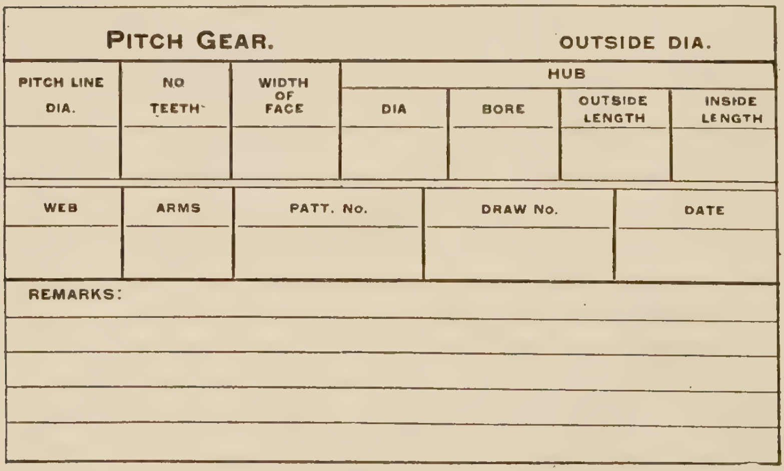
BUSHING. OUTSIDE DIA.

BODY		FLANGE		NOSE		MATERIAL
LENGTH	BORE	THICK	DIA.	DIA.	LENGTH	

PATT. NO.	DRAW. NO.	DATE

REMARKS:

FIGS. 53 and 54.—(Upper card): Record of pulley drawings, giving style, pattern number, and dimensions; (Lower card): Similar record for bushings. White cards 5 inches wide, 3 inches high.



PITCH GEAR. OUTSIDE DIA.

PITCH LINE DIA.	NO TEETH	WIDTH OF FACE	HUB			
			DIA	BORE	OUTSIDE LENGTH	INSIDE LENGTH

WEB	ARMS	PATT. No.	DRAW No.	DATE

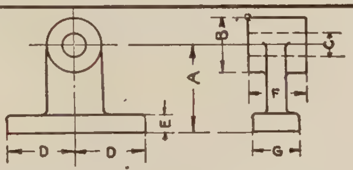
REMARKS:

FIG. 55.—Drafting department record for drawings of gears. White card, 5 inches wide, 3 inches high.

likely to make a number of different designs of such details, necessitating different patterns, different castings, and different tools for machining, when by a little foresight and system a single design of each detail, with but a single pattern, one variety of casting, and one set of tools, would have answered for all purposes.

Among such parts might be mentioned gears, bushings, levers, pulleys, bearing brackets, collars, bolts, nuts, and washers. If a card index record is kept of the above-named parts, recording briefly the dimensions adopted whenever such a part is designed, and this index is referred to whenever it becomes necessary to embody such parts in a design of any machine, considerable saving will result, due to the fact that the minimum variety of such details is maintained.

BEARING BRACKET. HIGH.=A.



B	C	D	E	F	G	REMARKS.

PATT. No	DRAW. No	DATE

Fig. 56.—Drafting department record for drawings of bearing brackets. White card, 5 inches wide, 3 inches high.

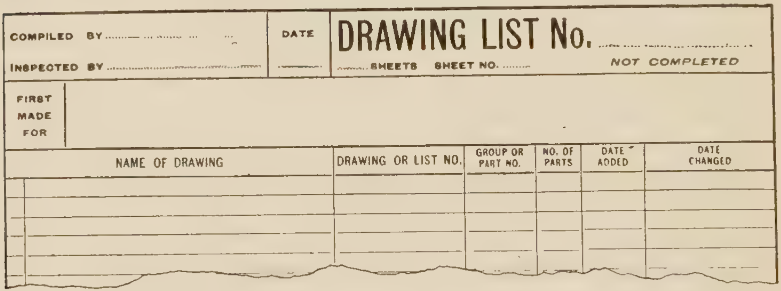
The two forms herewith given are such as are used for this purpose by a firm of leading printing-press builders, who take a particular pride in the fact that although they build intricate machines, these machines are composed of detail parts which appear over and over again through their whole line of designs, thus keeping down their expense for patterns, tools and storeroom space and records.

170. Recording Data for Standard Detail Parts.—Fig. 53 is a record of pulley drawings which gives all the dimensions and details as to style. Other blank spaces show the file number of the drawing and the pattern number. By reference to this card, which is filed in an alphabetical index, it can be ascertained at once whether the drawings on hand will fill the present need.

A similar file card for bushings is shown in Fig. 54. The details for filing are the same as on the pattern card, and the dimensions of the body, flange, and nose are given. These are samples of but many varieties of index cards which can be used in a convenient system of filing drawings.

Fig. 55 shows a form for recording data for gears, and Fig. 56 a form for recording bearing brackets.

Temporary drawings or sketches should never be used. It will take but a short time longer to get out a tracing and blueprint, and then there will be no risks run of losing the drawing or of questioning its having been tampered with.



COMPILED BY ....

INSPECTED BY ....

DATE

DRAWING LIST No. ....

.... SHEETS SHEET NO. .... NOT COMPLETED

FIRST MADE FOR

NAME OF DRAWING	DRAWING OR LIST NO.	GROUP OR PART NO.	NO. OF PARTS	DATE ADDED	DATE CHANGED

FIG. 57.—Form for drawing list covering all drawings pertaining to any one machine or order, a briefer reference than the complete bill of material. Pale green bond paper, 8 1/2 inches wide, 11 inches high. Thin paper.

171. Drawing Lists.—While the bill of material for a complete machine may give a list of all of the drawings, it is usually desirable to prepare for any one machine a complete drawing list, such list being confined only to the articles for which drawings are made, and serving an entirely different purpose from the bill of material, which lists minutely every item in the machine.

A form for drawing list is shown in Fig. 57.

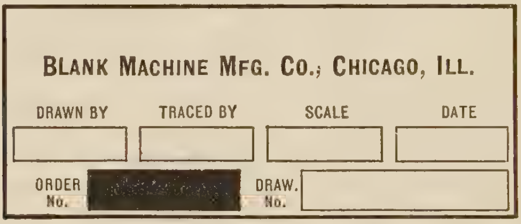
172. Filing Tracings.—A fireproof storage vault needs to be provided for the filing of tracings. The most convenient methods of filing will be a matter for deciding in the especial manufacturing establishment concerned. In some cases it might be advantageous to file tracings wholly by consecutive numbers, irrespective of dimensions. In other cases it will be desirable to file by class or dimension of sheets, and in still further cases it might possibly be desirable to have tracings for any one machine filed together. The last-named method, however, will generally conflict with the principle of using the same tracing and the same part in a number of different machines, and the same purpose is answered by the drawing list previously referred to. The most common device for filing tracings is a shallow vertical drawer with triangular metal corner pieces in the far inside corners, to prevent the tracings from curling up, and a piece of bent wire swinging in screw eyes inserted in the inside of the front of the drawer to act as a light weight. Sometimes a sheet of galvanized steel is used as a weight.

173. Stock of Blue-prints.—A stock of blue-prints is often desirable in order that there need be no delay in furnishing a blue-print when asked for. Such blue-print stock does not need to be in any fire-proof location, and can be kept in drawers similar to those described for tracings, in cabinets of a height such that the top of the cabinet forms a handy place for laying out a blue-print when consulting it.

174. Changes in Drawings or Patterns.—In changing drawings and patterns it is best to use an entirely new number for the changed drawing or pattern, and not to use any system of prefixes or affixes. The latter method merely complicates matters. When a drawing is changed a notation should be made referring to the number of the new drawing, and on the new drawing a notation should be made referring to the old one. In the case of patterns, if the old pattern is to be altered in order to make the new one, the pattern record must show such alteration. The alteration should always be made, if possible, in such a manner that the omission or addition of certain pieces will permit of the making of the casting of the old style. The reason for these policies in connection with changes is that it may be necessary to replace pieces of the old style, and it is not desired to carry any in stock, but it may be desirable to make them on short notice in accordance with the old style.

175. Blue-prints for Shop Use.—Blue-prints for shop use are usually carried in stock in a blue-print issuing room adjacent to the tool issuing room, and in many shops it is desirable that such blue-prints be mounted. They may be mounted on tarboard, and made washable and water-proof by giving them first a coat of white glue and then a coat of white Damar varnish. Curling may be prevented by pasting a blank piece of paper on the back of the mount. In place of tar-board galvanized steel may be used. The necessary smoothing off of the burr on the edge and the heavier weight of the steel make it disadvantageous in some respects, though it will outwear the tar-board as a mount.

176. Titles of Drawings.—Titles of drawings should contain sufficient information to tell all about the drawing without need of referring to any index. The title should designate the name of the complete machine or article which the drawing represents or of which it is a part, and should state also the name of the individual piece or pieces shown. It should designate the scale to which the drawing is made, the date drawn, by whom drawn, by whom traced, by whom checked.



BLANK MACHINE MFG. CO.; CHICAGO, ILL.

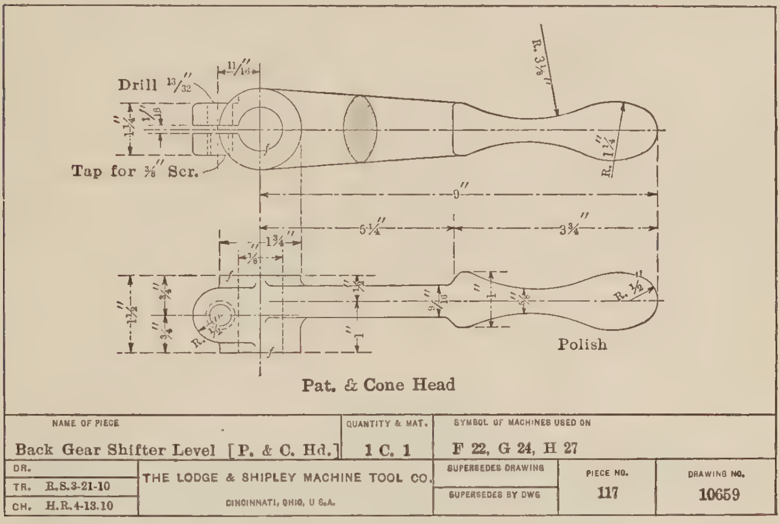
DRAWN BY	TRACED BY	SCALE	DATE

ORDER No. [redacted] DRAW. No.

FIG. 58.—Title printed on small piece of tracing cloth, 4 1/2 inches wide, 2 1/2 inches high.

A lot of time is wasted in many drawing rooms in making titles and border lines by hand. If border lines are wanted, they should be printed on all standard size tracing sheets. The title plate should be printed in on the lower right-hand corner, in order that it may be easily seen when the drawings are filed away in drawers. If there is considerable occasion to use tracing sheets of sizes other than standard, it may be found advantageous to have title form printed on small pieces of tracing cloth or tracing paper, and paste these on the lower right-hand corner of the special sized sheet. Fig. 58 shows a title blank printed on tracing cloth to serve this purpose.

177. Detail Drawings for Shop Use.—It has been found advantageous in many establishments to prepare distinct drawings for the shop, such drawings showing only the dimensions which are absolutely necessary for the shop to know in order to do the work that has to be done on the piece. Such shop drawings are most advantageously made to show but a single piece on one tracing or blue-print, and should specify limits of accuracy, gages to be used, etc. Some shops have found it to be a good practice to send a blue-print from the production department with each production tag, such blue-print and tag following the work through the shop. In order to keep the print and tag clean they may be put into an envelope of tough paper, such envelope bearing on the outside merely the shop order number, the mark number of the piece and the number of pieces. In this way the tag and blue-print will not get nearly as oily and dirty, nor are they as likely to become lost, as would be the case without the use of the envelope.



NAME OF PIECE Back Gear Shifter Level [P. & C. Hd.]	QUANTITY & MAT. 1 C. 1	SYMBOL OF MACHINES USED ON F 22, G 24, H 27

DR.
TR. R.S.3-21-10
CH. H.R.4-13.10

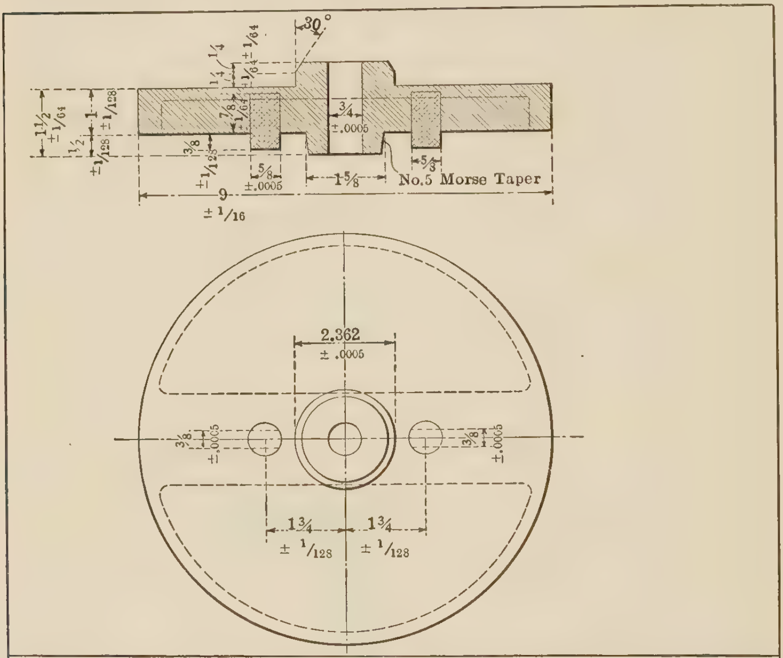
THE LODGE & SHIPLEY MACHINE TOOL CO.
CINCINNATI, OHIO, U.S.A.

SUPERSEDES DRAWING
SUPERSEDES BY DWG
PIECE NO. 117
DRAWING NO. 10659

FIG. 59.—Shop blue-print gummed to inside cover of traveler. Approximately 6×8 in.

Fig. 59 shows a shop detail blue-print as used by the Lodge & Shipley Machine Tool Co., and pasted into each shop "traveler-book" along a gummed edge on the inside of the cover. The "traveler-book" contains a number of slips bound together in proper consecutive order, each slip being a work order for a specific operation, and serving when torn out and clock-stamped, as a record of the workman's time on that operation. The size of this blue-print is approximately 6 in. by 8 in., so that when the 8-in. length is folded in half it fits standard filing devices for 4-in. by 6-in. cards. The "follower-book" is 4 in. by 6 in.

178. Specifying Limits of Accuracy.—Each drafting room should agree with the proper shop authorities on a standard table of ordinary clearances to be used in machine-tool work, and all machinists should be furnished with a table specifying these clearances. Standards should be agreed on for drive, press, or shrink fits, running fits, and special fits peculiar to certain products.



FERRACUTE MACHINE CO. PIECE NAME CENTER PLATE-SCALE-½ PIECE SYMBOL AN 13a13

CUSTOMER Fenwick Freres & Co. ORDER 26835a QUANTITY DATE 4/18,1911

ROUTING	SPECIAL TOOL	INSTRUCTION	ROUTING	SPECIAL TOOL	INSTRUCTION	MATERIAL I.C.
1,			9,			WEIGHT, ROUGH LBS.
2,			10,			WEIGHT, FINISHED LBS.
3,			11,			DESIGNER O.Smith
4,			12,			DRAFTSMAN C.Taylor
5,			13,			CHECKED BY L.C.M.
6,			14,			APPROVED L.C.M.
7,			15,			12800-C
8,			16,			

FIG. 60.—Shop blue print specifying limits of accuracy. Red cross-section lines as well as black border and printed matter at bottom of sheet are printed on the standard size tracing sheets.

In order that there may be no mistake as to clearances and tolerances it is well to specify them not only on tables, but also on shop blue-prints.

Fig. 60 shows a blue-print as used by Frederic A. Parkhurst at the Ferracute Machine Co., showing proper fits.

179. Making and Issuing Blue-prints.—For printing purposes the cylindrical arc light printing machine is the most dependable process. It is well to provide sunlight printing facilities, however, for emergency use. An outdoor platform or balcony on to which trucks containing the printing frames can be run, and set so that the frame may be tilted in any direction, will be found much more convenient than the usual method of running tracks out of a window to hold the truck supporting the frame.

Facilities should be provided in every first-class drafting room for photographic development and printing.

It is desirable to post all requisitions for blue-prints received from various departments and individuals on to a permanent record, in which a separate card is used for each tracing. On this card will be recorded the date on which any print was issued, and to whom it was issued. This record serves not only as a check on what persons received blue-prints, but is also a guide as to how large a stock of prints of each tracing should be carried on hand ready for issuance.

It is important that the recording and clerical part of a drafting department be kept in excellent order.

180. Checking Drawings.—The checking work should not be delegated to the chief draftsmen, but should be the duty of one man, whose first duty it must be. He should check not only from the standpoint of dimensions, but from a standpoint of ease of processing. The policy of standardization should always be borne in mind. The drafting department must be supplied with as many lists as may be necessary of the shop's standards as to reamers, taps, etc. Designing should always be done in such a way as to consider cheapest and most efficient methods of machining, assembling, and processing in general.

There should be a system of collecting and recording all criticisms of drawings made in machining, assembling, or erecting departments. Where there is any discrepancy apparent in the drawing the best rule is that work should be stopped and the drawing taken at once to the drawing room for correction or interpretation.

181. Time-cards in Drafting Department.—Time-cards should be turned in by draftsmen to show the relative cost of drawings. A record of the results of these time-cards should be kept not only in the cost department, but also in the drafting department, so that the head of the drafting department may have some knowledge of costs of drafting work based on actual records of performance. Not only the order number should be recorded on the time-tickets, but also the nature of the drawing, its number, and whether the work done was designing, sketching, tracing, etc. Standing non-productive orders should be issued, to be closed monthly, to determine the cost per month of filing, blue-printing, and other maintenance expense of the drafting department.

182. Chief Draftsman.—The head of the drafting department needs to be relieved of as much routine work as possible, outside of that connected with the time at which drawings for certain orders should be completed. In this respect he should be as thoroughly posted as the head of the shop production department. He should be provided with a list of all orders for which drawings are required, and also a complete list of all drawings which have to be made, together with the date at which they are to be ready. He should hold department meetings and consultations at stated times, in order to have the output of his department correspond as nearly as possible to the requirements of the business.

The head of the drafting department should be a man with knowledge of machinery used in his line of work, and of the best methods of foundry and machine-shop practice in general. He should be constantly going over current product with a view of having ready plans for redesigning, to be put into effect the moment the policy of the company as to adhering to standards once established will permit of putting the improvement into effect.

REFERENCES

Perrigo: "Modern Machine-shop Construction, Equipment and Management," Chapter XIX.

Carpenter: "Profit Making Management," Chapter IV.

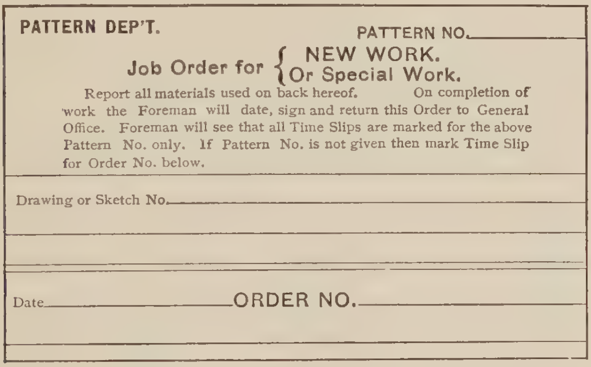
Parkhurst: "Applied Methods of Scientific Management," pp. 27–36.

CHAPTER XIV

THE PATTERN DEPARTMENT

183. Orders to Make Patterns.—Orders to make new patterns usually come direct from the drafting department or the bill of material department to the pattern-making department, in case the factory has its own pattern-making department. If patterns are not made in the factory, but are bought outside from a jobbing pattern shop, then the shop order will be replaced by a requisition on the purchasing department or a request on the stores department to make a requisition on the purchasing department.

Fig. 61 is a form for an order to make a pattern in the shop.



PATTERN DEP'T.

PATTERN NO.__________

Job Order for { NEW WORK. / Or Special Work.

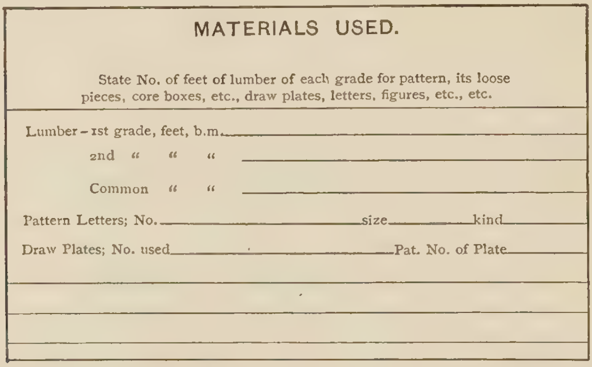
Report all materials used on back hereof. On completion of work the Foreman will date, sign and return this Order to General Office. Foreman will see that all Time Slips are marked for the above Pattern No. only. If Pattern No. is not given then mark Time Slip for Order No. below.

Drawing or Sketch No.__________

Date__________ ORDER NO.__________

FIG. 61.—Form for pattern order. Manila card, 5 inches wide, 3 inches high.

The pattern-making department is furnished one copy of this order. Another copy is sent to the cost department. The amount of material used is posted by the pattern-maker or the foreman of the pattern-making department on the back of this order card. Fig. 62 shows the back of the card as used for reporting materials consumed in making the pattern. When the pattern is completed, it is sent with the order card to the pattern storage department, where the pattern storage clerk records it in his record of patterns, and assigns it a place in the storage vault or building. The pattern storage clerk fills out a record similar to Fig. 63, which describes the pattern, shows where it is located in the pattern storage racks, and he then sends the order on to the cost department, showing that he has received the completed new pattern.



MATERIALS USED.

State No. of feet of lumber of each grade for pattern, its loose pieces, core boxes, etc., draw plates, letters, figures, etc., etc.

Lumber – 1st grade, feet, b.m.

2nd " " "

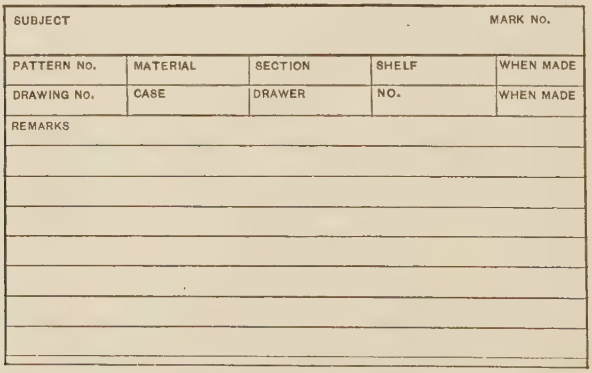
Common " "

Pattern Letters; No. size kind

Draw Plates; No. used Pat. No. of Plate

Fig. 62.—Reverse of form shown in Fig. 37. Pattern-maker's report of material used on an order. Manila card, 5 inches wide, 3 inches high.

184. Time-keeping System in Pattern Shop.—It is sometimes desirable to have the time-keeping system in the pattern department different from the general time-keeping system, as the department is apt to be a small one, and in an isolated location some distance away from larger shop departments where a different time-keeping system may be preferable. There will always be more or less repair work on patterns and flasks going on in the



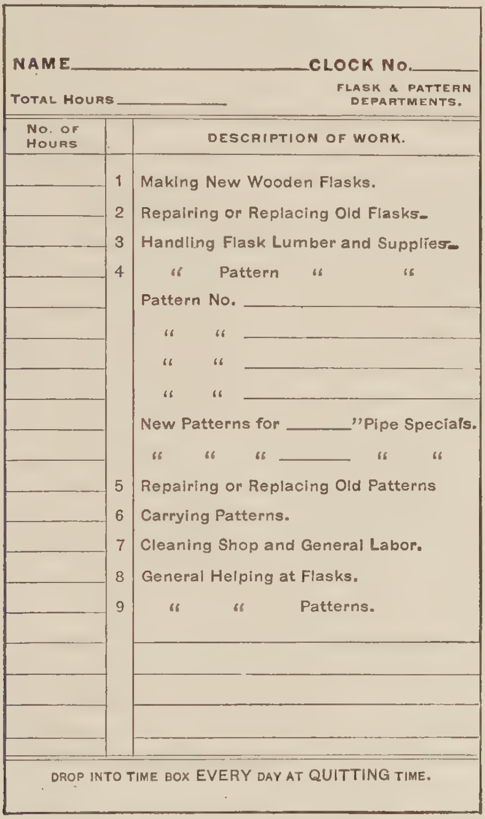
SUBJECT MARK NO.

PATTERN NO.	MATERIAL	SECTION	SHELF	WHEN MADE
DRAWING NO.	CASE	DRAWER	NO.	WHEN MADE

REMARKS

Fig. 63.—Pattern storage record. White card, 5 inches wide, 3 inches high.

pattern-making department, which fact will be a reason for the over-head or operating expense rate of the pattern shop being quite heavy. Fig. 64 shows a time-card to be filled out by each pattern-maker, which provides spaces for filling in the pattern-maker's non-productive time. The pattern-making foreman will have to spend some time in looking over these time-cards, to see that the time is correctly distributed.



NAME____________________ CLOCK No.________

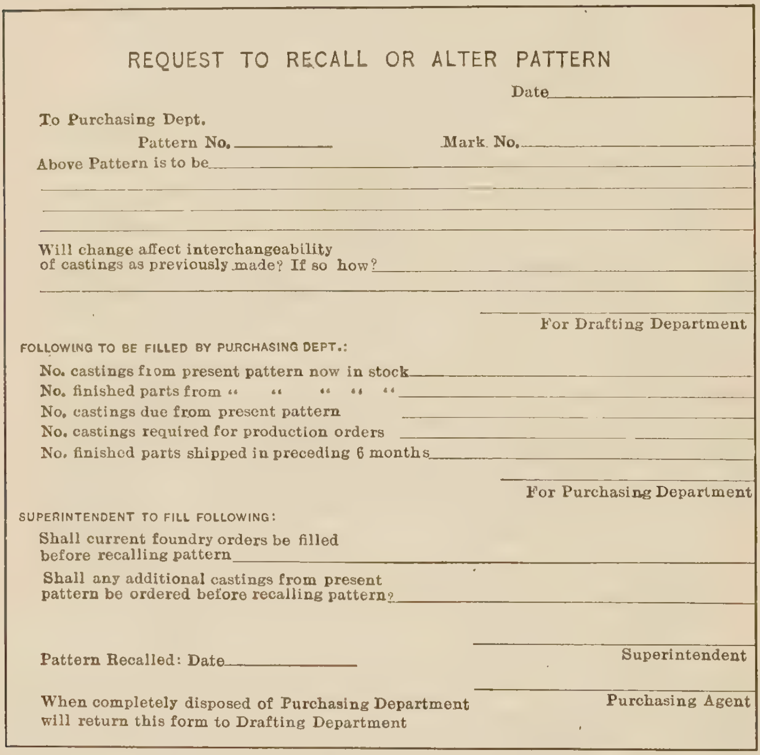
TOTAL HOURS__________ FLASK & PATTERN DEPARTMENTS.

No. of Hours		Description of Work.
	1	Making New Wooden Flasks.
	2	Repairing or Replacing Old Flasks.
	3	Handling Flask Lumber and Supplies.
	4	" Pattern " "
		Pattern No. __________
		" " __________
		" " __________
		" " __________
		New Patterns for ______ "Pipe Specials.
		" " " ______ " "
	5	Repairing or Replacing Old Patterns
	6	Carrying Patterns.
	7	Cleaning Shop and General Labor.
	8	General Helping at Flasks.
	9	" " Patterns.

DROP INTO TIME BOX EVERY DAY AT QUITTING TIME.

Fig. 64.—Time-card for pattern-maker. Manila card, 3 1/2 inches wide, 6 inches high.

185. Recalling or Altering Patterns.—Where an establishment gets its castings from a number of different foundries, as is very often the case in a concern using many steel castings, the matter of recalling or altering patterns is one which will involve consideration of a number of questions affecting production. These considerations are fully set forth in the form shown in Fig. 65, which is a request to recall or alter a pattern. This request emanates from the drafting department, which states the nature of the change or the reason for the recall, and also states whether the change will affect interchangeability and how. The form next goes to the purchasing department, which department, in the establishment in which this particular form was used, had charge of the pattern storage department. The purchasing department looks up the stores records, and fills out the blanks, specifying the number of castings from present pattern now in stock, the number of finished parts from present pattern now in stock, the number of castings required for production orders, and the number of finished parts shipped in preceding six months. When the purchasing department has filled in this information,



REQUEST TO RECALL OR ALTER PATTERN

Date________________

To Purchasing Dept.

Pattern No.__________ Mark. No.________________

Above Pattern is to be______________________________

Will change affect interchangeability
of castings as previously made? If so how?________________

For Drafting Department

FOLLOWING TO BE FILLED BY PURCHASING DEPT.:

No. castings from present pattern now in stock________________

No. finished parts from " " " " "________________

No. castings due from present pattern________________

No. castings required for production orders________________

No. finished parts shipped in preceding 6 months________________

For Purchasing Department

SUPERINTENDENT TO FILL FOLLOWING:

Shall current foundry orders be filled
before recalling pattern________________

Shall any additional castings from present
pattern be ordered before recalling pattern?________________

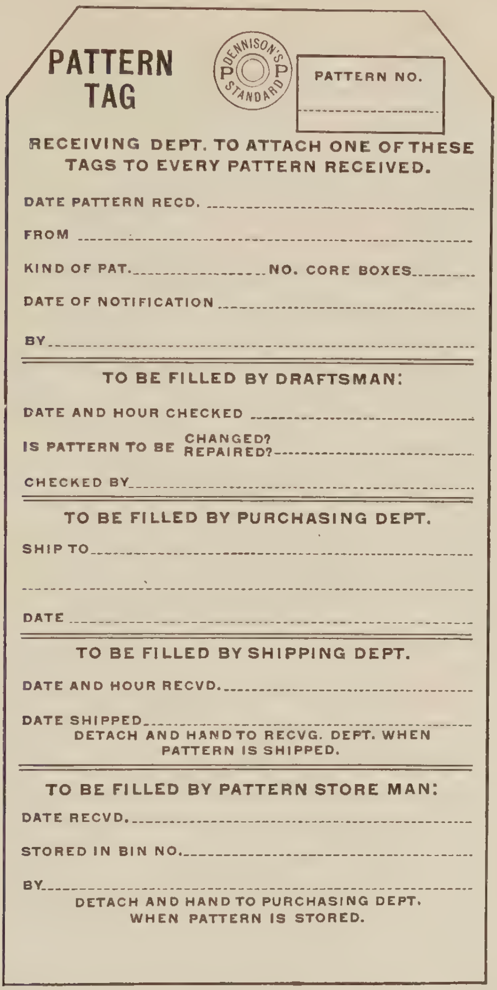
Pattern Recalled: Date__________ Superintendent

When completely disposed of Purchasing Department
will return this form to Drafting Department

Purchasing Agent

FIG. 65.—Authorization for pattern changes or recall. White paper, 9 inches wide, 11 inches high.

the form is sent to the superintendent, who answers the questions, "Shall current foundry orders be filled before recalling pattern?"



PATTERN TAG

DENNISON'S STANDARD

PATTERN NO. ____

RECEIVING DEPT. TO ATTACH ONE OF THESE TAGS TO EVERY PATTERN RECEIVED.

DATE PATTERN RECD. ____

FROM ____

KIND OF PAT. ____ NO. CORE BOXES ____

DATE OF NOTIFICATION ____

BY ____

TO BE FILLED BY DRAFTSMAN:

DATE AND HOUR CHECKED ____

IS PATTERN TO BE CHANGED? REPAIRED? ____

CHECKED BY ____

TO BE FILLED BY PURCHASING DEPT.

SHIP TO ____

____

DATE ____

TO BE FILLED BY SHIPPING DEPT.

DATE AND HOUR RECVD. ____

DATE SHIPPED ____

DETACH AND HAND TO RECVG. DEPT. WHEN PATTERN IS SHIPPED.

TO BE FILLED BY PATTERN STORE MAN:

DATE RECVD. ____

STORED IN BIN NO. ____

BY ____

DETACH AND HAND TO PURCHASING DEPT. WHEN PATTERN IS STORED.

FIG. 66.—Pattern tag attached by receiving department, giving record of disposition and finally filed in purchasing department to show location of pattern. Manila tag stock with reinforced eyelet, 3 1/8 inches wide, 6 1/2 inches high.

and "Shall any additional castings from present pattern be ordered before recalling pattern?"

This method puts the responsibility of tying up production on the shop superintendent, and relieves the drafting department of any authority to hold up delivery of castings by reason of changes in patterns.

186. Checking Patterns and Recording Their Travel and Location.—Where patterns are continually coming in and going out from and to various foundries, a pattern tag, similar to Fig. 66, will be found very useful. This pattern tag is attached by the receiving department to every pattern received. The receiving department fills in the first section of the tag, which designates the pattern number, the date the pattern was received, from whom it was received, the kind of pattern, the number of coreboxes, and the date on which the receiving department notified the drafting and purchasing departments of the receipt of the pattern.

As soon as the drafting department receives notice from the receiving department that a pattern is in (such notice being on a separate notification slip shown in Fig. 134), a representative of the drafting department is sent to check the pattern. The draftsman fills in the result of his checking on the tag in the second space, specifying whether the pattern needs to be changed or repaired. The purchasing department next sends a representative to the pattern, or better, a representative from the purchasing department makes daily visits to the receiving department and fills in the third space on the tag designating where the pattern is to be shipped. If it is to go to pattern storage, he so designates in the space. The next space is for the shipping department to fill in in case the pattern is to be shipped out. The shipping department then sends the tag to the purchasing department. If the pattern, instead of having to be shipped out, is to go to pattern storage, the shipping department space is left blank, and the pattern storage man fills in the last space, designating when he received the pattern and where he has stored it.

The tags as returned to the purchasing department are there filed, according to numbers, in two boxes, one box representing patterns out at various foundries, the other box representing patterns in the storage department at the shop. This enables the purchasing department to state the location of any pattern in current use at a moment's notice.

REFERENCE

Perrigo: "Modern Machine-shop Construction, Equipment and Management," Chapter XXX.

CHAPTER XV

THE PURCHASING DEPARTMENT

187. Functions of Purchasing Department.—The functions of the purchasing department in a manufacturing establishment may be stated as follows:

First.—To secure the most satisfactory material, such material including raw and finished material required in the manufacturing processes, equipment, and general supplies.

Second.—To secure the most desirable delivery of the material, keeping complete and accurate record of all unfilled purchase orders. Deliveries and mistakes must be kept account of.

Third.—To obtain the best terms of payment and the lowest prices.

Fourth.—To record and classify all materials, equipment, and supplies used by the establishment, list for easy reference the names of all firms supplying these goods, and all purchases made. The order in which the above functions have been mentioned is usually the order of their relative importance.

188. Qualifications of Purchasing Agent.—The successful accomplishment of the first function demands that the purchasing agent shall be a man who has a working knowledge of the particular industry for which he is to buy material. If he has in addition a knowledge of the fundamental principles of the resistance of materials, of metallurgy, and of machinery, so much the better, for he will be able to make practical application of such knowledge.

That the purchasing agent be the possessor of practical manufacturing knowledge is just as essential in an establishment which refers its tests of materials to a testing laboratory, or to its engineering department or superintendent, as in a smaller establishment which does not conduct such tests. If care is exercised to obtain a man of the qualifications indicated to fill the position of purchasing agent, there will be far less liability to the error, frequently made, of buying material good enough in itself, but not exactly adapted to the particular purpose for which it is desired.

It is assumed at the outset, that persons other than the purchasing agent will have specified the exact physical or chemical properties of the articles that are the most important constituents of the manufacturing product of the establishment. But there is no manufacturing process so simple that it does not require the purchase of a great variety of minor articles, the examination of each one of which by the engineering department would be a useless burden. And it is here, as well as in the purchase of general supplies, that the purchasing agent's training and experience come into active play.

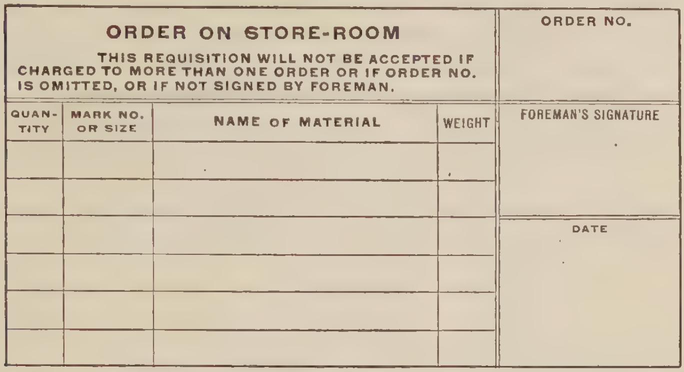
To salesmen, the ignorant, affable young clerk who has been promoted to the position of purchasing agent is a familiar type. He is frequently the cause of a salesman's prolonging his stay in a city several days, until finally he sees the man with whom he can have an intelligent conversation. It is quite evident that, where this is the case, the young man is a hindrance from an economic standpoint, since the additional cost of sales departments on account of prolonged stays is sufficient to increase materially the unnecessary expense connected with the placing of an article on the market.

The securing of the most desirable delivery involves a knowledge of business methods and forms, in which, unfortunately, purely technical or shop men have generally had but little training; and this fact is the excuse for the common practice of appointing as purchasing agents, clerks who have had but little technical or shop knowledge.

A thoroughly systematic conduct of the purchasing office, such as is absolutely essential to insure the proper attention to this very important matter of delivery, is much facilitated by the use of certain forms. Some examples will be cited of such forms, which must, however, be modified to suit the requirements of any particular case.

189. Requisitions on Purchasing Department.—It is very customary for other departments to lay the blame for delays in manufacture upon delays in receipt of material. Hence it is important that a written record be kept showing the originating dates of all calls for materials. In many establishments the first step in connection with the making out of a bill of material is the issuing of the requisitions for such material as it is known must be purchased.

The purchasing department should be supplied by the general manager with a list of all departments authorized to make requisitions direct on the purchasing agent, together with a statement as to the nature of goods for which such department may make requisition. For instance, it is usually desirable to confine the making of requisitions for equipment to a certain department, making of requisitions for materials to certain other departments, the making of requisitions for general supplies to another department, etc. Hence separate series of requisitions are useful, designated by different prefix letters and printed on different colors of paper. It is not desirable to permit shop foremen to make requisitions direct on the purchasing agent. They should make requisitions on the storeroom for such materials or supplies as



ORDER ON STORE-ROOM

THIS REQUISITION WILL NOT BE ACCEPTED IF CHARGED TO MORE THAN ONE ORDER OR IF ORDER NO. IS OMITTED, OR IF NOT SIGNED BY FOREMAN.

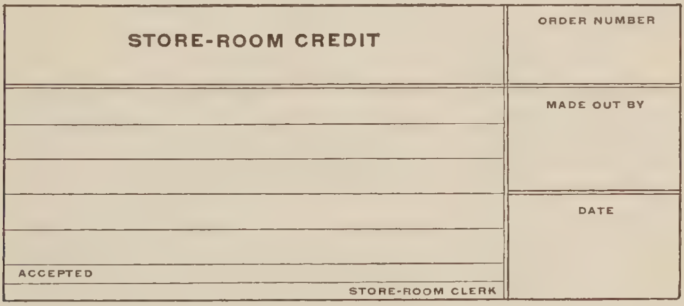
ORDER NO.

QUANTITY	MARK NO. OR SIZE	NAME OF MATERIAL	WEIGHT

FOREMAN'S SIGNATURE

DATE

FIG. 67.—Order on storeroom used to authorize withdrawal of supplies and components not issued with regular production tags. Yellow bond paper, 3 inches wide, 5 inches high.



STORE-ROOM CREDIT

ORDER NUMBER

MADE OUT BY

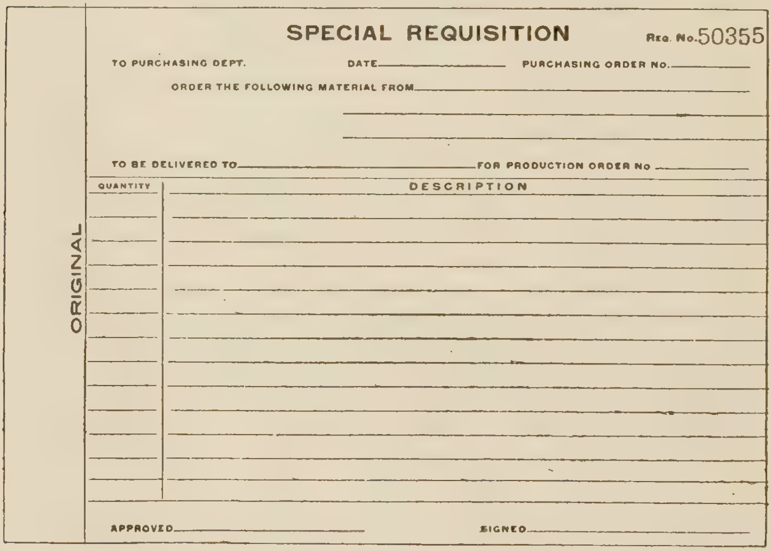
DATE

ACCEPTED

STORE-ROOM CLERK

FIG. 68.—Storeroom credit. Turned in to storeroom with unused supplies, bulk material, bar or sheet stock of which only a portion has been used on a given order. Pink bond paper, three inches wide, 5 inches high.

they need, such requisitions being usually called "Order on Storeroom," and bearing the order number of either productive or non-productive series to which the items are to be charged. Usually small tools are reported on a separate form or "Order on Tool-room," to cover withdrawals of new tools, such as files, drills, etc. Fig. 67 shows a form for "Order on Storeroom," and Fig. 68 a form for credit-slip to be used in returning excess material, such as bar stock of steel or brass after having cut off a piece. Where a production department exists, which sees that the necessary material is provided for all production orders and delivered to the shop when the order is ready to have work begin on it, the orders on stores will have a tendency to narrow themselves down to factory supplies and tools. They may also serve as requests for delayed material. When used for this purpose they must be distinguished in some way from the other storeroom orders so as to avoid posting them by mistake as storeroom withdrawals.



ORIGINAL

SPECIAL REQUISITION REQ. NO. 50355

TO PURCHASING DEPT. DATE ______ PURCHASING ORDER NO. ______

ORDER THE FOLLOWING MATERIAL FROM ______

TO BE DELIVERED TO ______ FOR PRODUCTION ORDER NO ______

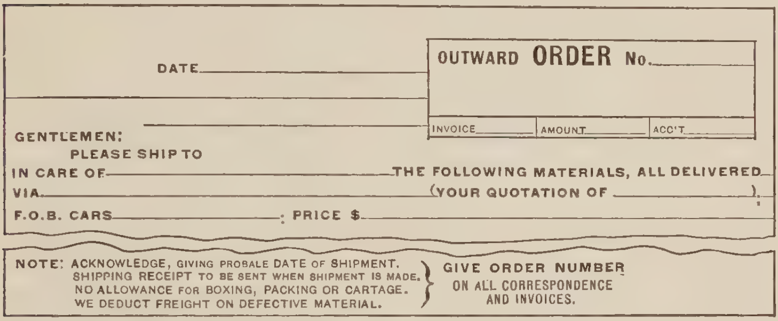
QUANTITY	DESCRIPTION

APPROVED ______ SIGNED ______

FIG. 69.—Form for requisition on purchasing agents. White bond paper, 8 inches wide, 5 5/8 inches high.

Fig. 69 shows a form for requisition on purchasing agent. This is usually best written in triplicate. In departments that have to write a good many requisitions, the autographic register is frequently found useful in writing, viz., a machine in which the paper is fed in rolls and the carbon is fed crosswise as it wears out. The original is sent to the purchasing department, as is also the duplicate, the triplicate being kept on file. When the purchasing department has filled in the purchasing order number, the duplicate is returned to the department in which the requisition originated.

In making requisitions and purchase orders for castings it will be found most satisfactory to issue a separate requisition and separate purchase order for each separate pattern number. At first sight this would seem like a great many useless orders, but experience has demonstrated that partial deliveries are far more easily checked off on an order referring to castings from but a single pattern than if a given order carries partial deliveries on a variety of patterns. It also enables one to remove at once all orders for castings from a given pattern as soon as the deliveries on that pattern are completed.



OUTWARD **ORDER** No.

DATE

INVOICE AMOUNT ACC'T

GENTLEMEN:
PLEASE SHIP TO
IN CARE OF THE FOLLOWING MATERIALS, ALL DELIVERED
VIA (YOUR QUOTATION OF);
F.O.B. CARS ; PRICE $

NOTE: ACKNOWLEDGE, GIVING PROBALE DATE OF SHIPMENT.
SHIPPING RECEIPT TO BE SENT WHEN SHIPMENT IS MADE.
NO ALLOWANCE FOR BOXING, PACKING OR CARTAGE.
WE DEDUCT FREIGHT ON DEFECTIVE MATERIAL.

GIVE ORDER NUMBER
ON ALL CORRESPONDENCE
AND INVOICES.

Fig. 70.—Form for purchase order. White bond paper, 8 1/2 inches wide, 11 inches high.

190. Purchasing Department Order Form.—As to the form of the purchase order itself, there are still a good many houses using the old-style bound book of orders with stubs, for the reason that then there is one place where there is a bound set of all orders. This method necessitates the writing of an index book. The more general method is to typewrite all copies, there being usually at least three, filing one set of carbon copies alphabetically, and the other serially by numbers. A further reference file is a large card index arranged alphabetically bp materials, and so ruled as to allow the entering of all purchase orders for a given kind and size of material, and with spaces permitting of partial deliveries. Such a large card record serves as an entry record of all invoices, and also for all prices paid for a given article, as well as a guide to the time that was taken to make delivery after orders were placed.

Fig. 70 is a form for purchase order. On the bottom of the sheet are printed the terms on which the order is placed. From a legal standpoint it is usually best to place these terms between the name and address at the head of the order and the body of the order itself, thus making the terms form an integral part of the communication.

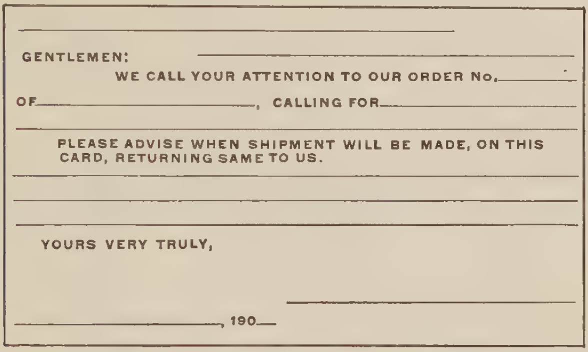
An additional carbon copy of the purchase order is usually sent to the receiving department. Some firms prefer to send a notice to the receiving department which does not specify the quantity called for, so as to insure the actual counting of goods delivered on the part of the receiving department.

191. Following up Deliveries.—The Shannon type of prong file or a loose leaf binder is usually used for filing the copies of purchase orders. If a firm has a great many purchase orders, extra long prongs may be used on the files, and a number of different sets of boards may be used, each file-board containing only a part of the entire series. As soon as a purchase order has been completed, it is taken off the file-boards containing uncompleted orders, and transferred to the file-boards of filled orders. Some firms attach one of the copies of the completed purchase order, together with the requisition, to the voucher. This system involves some complications when invoices are approved which cover only partial deliveries on a given purchase order. In such cases extra copies may have to be typewritten of the purchase order and the requisition, for the purpose of attaching to the voucher, the originals remaining on file until the last delivery on the order has been made.

Where a factory has a number of departments to which purchased articles have to be delivered, the copy of the purchase order which is sent to the receiving department should bear a notation stating to which department the goods are to be delivered, also the requisition number which it fills.

A simple method of securing promises of delivery is to enclose a printed post-card acknowledgment of order, with blank for promise of delivery. Fig. 71 shows a form of such post-card promise. To keep track of promises it is very convenient to have a set of thirty-one pigeon-holes, each pigeon-hole representing a day of the month, and each hole containing the postal cards or other memoranda of all shipments which should arrive on that day. This file affords a systematic method of stirring up delinquent shippers, the additional promises being noted on the memoranda as they are transferred from one pigeon-hole to another.

Where an establishment is located in a large city, and many orders are local, it is best to separate the city orders from the others, so that they can be followed up by telephone instead of by mail. For this purpose it may be well to have a separate series of purchase orders for local use, distinguishing them by some convenient prefix letter.



GENTLEMEN:

WE CALL YOUR ATTENTION TO OUR ORDER No.

OF , CALLING FOR

PLEASE ADVISE WHEN SHIPMENT WILL BE MADE, ON THIS CARD, RETURNING SAME TO US.

YOURS VERY TRULY,

, 190

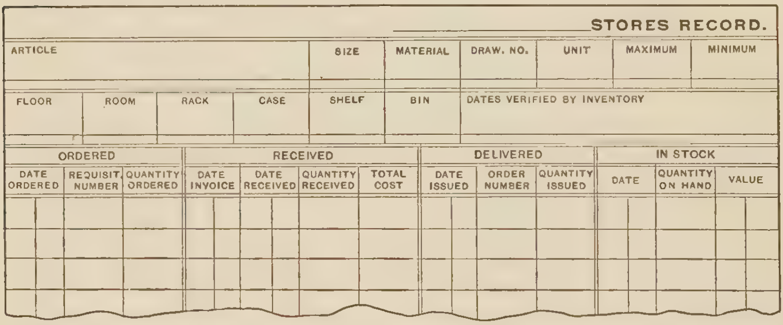
Fig. 71.—Return post-card for promise date of shipment of purchase order, 5 1/2 inches wide, 3 1/4 inches high.

192. Securing Favorable Terms.—As to the third function of the purchasing department which was mentioned, namely, that of securing good terms and low prices, much depends on the shrewdness and tact of the purchasing agent. Courteous attention to salesmen is always desirable, and can be accorded without loss of time, if nothing but strictly business conversation is indulged in.

The mere request for a little more liberal cash discount than is usually given will frequently result in its being allowed, and the same is true of securing deferred payments, where they are desired. The cash-discount system, if applied to all purchases, however small, will result in a considerable annual saving. It is well worth remembering that cash discounts are obtainable on small amounts as well as large.

193. Recording and Classifying Material, Equipment, and Supplies.—The fourth function, that of recording and classifying all materials, equipment, and supplies used by the company, and knowing who the suppliers are, and what are their prices, demands the keeping up of several additional indexes and files. A card index of quotations and prices, arranged alphabetically by names of materials, with sub-cards for various sizes, will be found desirable. Sometimes pocket editions, abridged, of this price-list, made in alphabetical pocketbook form, will be desirable, so that they may be carried about in the pocket, out of the office.

The large card record of invoices posted on material cards, as already referred to, serves as a record of prices actually charged for goods actually purchased, as a distinct record from the quotation and price index just described. In a small establishment this invoice record may also serve as a stores record. A form for such combined record is shown in Fig. 72.



STORES RECORD.

ARTICLE	SIZE	MATERIAL	DRAW. NO.	UNIT	MAXIMUM	MINIMUM
FLOOR	ROOM	RACK	CASE	SHELF	BIN	DATES VERIFIED BY INVENTORY

ORDERED			RECEIVED				DELIVERED			IN STOCK		
DATE ORDERED	REQUISIT. NUMBER	QUANTITY ORDERED	DATE INVOICE	DATE RECEIVED	QUANTITY RECEIVED	TOTAL COST	DATE ISSUED	ORDER NUMBER	QUANTITY ISSUED	DATE	QUANTITY ON HAND	VALUE

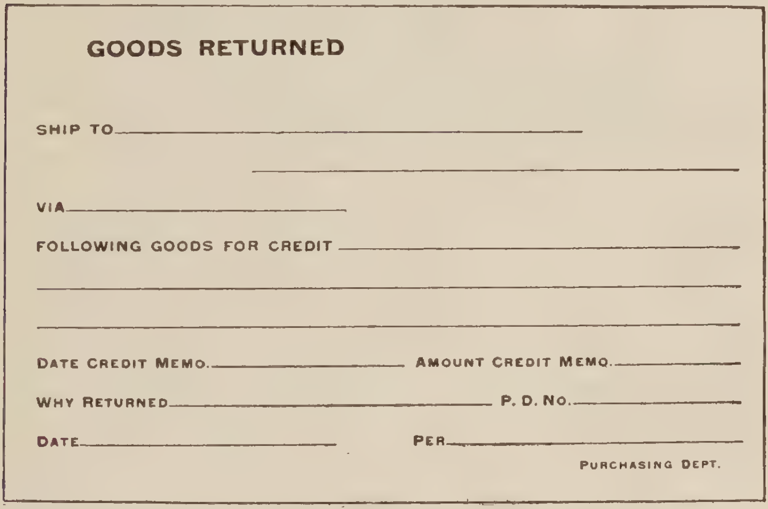
FIG. 72.—Combined purchase order record. Invoice record, and stores record, serving also as material price catalogue, for use in small establishments. White card, 6 inches wide, 4 inches high, red and blue ruling.

A catalogue cabinet will have to be provided with card indexes by class of material, and by name of supplier. With a double index of this sort it is immaterial in what order the catalogues are arranged, an arrangement by size of catalogue being usually the most satisfactory.

194. Returned Goods.—Wrong or unsatisfactory goods must be promptly returned. For this purpose a notice should be sent to the shipping department, and a copy sent to the billing department. Fig. 73 shows a convenient form for this purpose.

Where a considerable number of contracts are made for materials and supplies, a separate contract file or safe will be found desirable.

195. Freight, Express and Drayage.—Separate accounts are usually kept by the purchasing department of such matters as drayage, freight, express, insurance, and other special matters, as the nature of the business may require. In the matter of drayage, freight, and express, it is very important that close scrutiny be kept by the purchasing department, so as to avoid needlessly large expenses in these directions. Requisitions must be made in sufficient time to avoid express shipments. Also the purchasing department may find it desirable to lump orders with a jobbing supply house occasionally, to reduce cost of freight and drayage that would be entailed by placing a lot of small orders with various manufacturers, thus getting in one package, and with one charge for freight and hauling, a lot of items that might make twenty or more packages if bought direct from the various manufacturers, necessitating the paying of freight and haulage on each of the twenty packages. Moreover, a jobbing-house is often apt to make quicker delivery on small orders than the manufacturer, who will fill his important orders first and let the minor orders wait.



GOODS RETURNED

SHIP TO

VIA

FOLLOWING GOODS FOR CREDIT

DATE CREDIT MEMO. AMOUNT CREDIT MEMO.

WHY RETURNED P. O. NO.

DATE PER

PURCHASING DEPT.

FIG. 73.—Notice by purchasing department to accounting department of goods returned for credit, 6 inches wide, 4 inches high. Thin white paper.

196. Checking Invoices.—It is the duty of the purchasing department to check invoices as to correctness of quantity and price. Invoices should not be sent to the receiving department to check, but should be kept in the purchasing department. A record book should be kept of all invoices received, showing date received, and when and to whom they were sent.

In some establishments it is very desirable that the purchasing department make a daily estimate of the value of all goods ordered during that day, or rather during the previous day, with estimated dates at which payments will become due.

REFERENCES

Going: "Principles of Industrial Engineering," Chapter IX.
Ennis: "Works Management," Chapter V.
Brisco: "Economics of Business," Chapter X.
Cook: "Factory Management," Chapter III.

CHAPTER XVI

STORES AND STOCK DEPARTMENT

197. Classification of Materials.—After the bill of material has been prepared, and the necessary drawings and patterns have been provided for, the next steps in the manufacturing process are those dealing with the getting in of the materials of construction and the making of the finished parts in the shop.

Raw materials purchased outside, and which have to have work done on them in the shop before they become finished parts, are usually designated as "Stores," and the records dealing with this class of material are called "Stores Records."

Parts which have all the work done on them necessary to make them ready for assembling into machines or into assembly groups of machines are usually designated by the name "Finished Parts," and the records dealing with this class of parts are frequently called "Finished Parts Records." The last-named parts are sometimes designated by the word "Stock," and the records called "Stock Records." The term "Stock" is most generally used to designate finished product ready for shipment. Perhaps the most definite way of designating all materials is as follows:

(a) "Stores," consisting of raw material which must go through or enter into some manufacturing process in the shop. In this class would come pig iron, coal, castings, bar steel, paint, etc.

(b) "Purchased Finished Parts," consisting of all parts ready to use in assembling or as repair parts, which are purchased outside the shop in their finished state. In this class would come standard bolts, screws, etc., or radiators, tires, etc., in an automobile factory.

(c) "Manufactured Finished Parts," consisting of all parts which must be manufactured in the shop.

(d) "Finished Product," consisting of the stock of completely assembled machines or other manufactured article, and sometimes of a stock of assembled groups in excess of such groups as are required for manufacturing and assembling machines, such as extra armatures, etc.

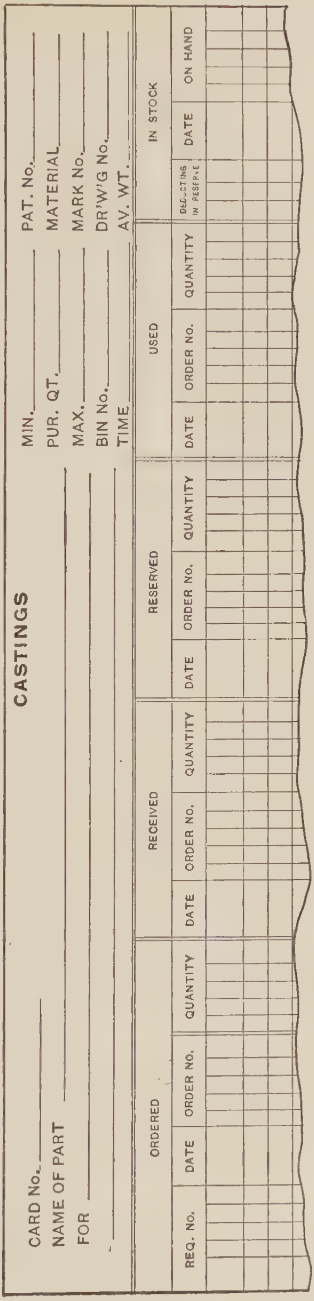
(e) "Supplies," including all materials not entering directly into manufactured product, but necessary in the conduct of the business.

It is the custom in some establishments to designate the articles in classes (b), (c), and (d) above as "Stock." It will be found, however, that a differentiation of departmental records in accordance with the classification given above will generally be advantageous even though the accounting department's double-entry books may carry only a single "Materials" account.

198. Perpetual Inventory of Castings.—Fig. 74 shows a form for keeping record of castings. At the left-hand upper portion of the record are spaces for the name of the part for which the casting is used, and the name of the machine of which it is a part. At the right are spaces for designating the pattern number, the kind of material, the mark number, the drawing number, and the average weight of the castings; also the minimum stock, the purchasing quantity, the maximum stock in excess of orders, the bin number in which the castings are located in the castings warehouse, and the time usually required to get castings in from the foundry.

There are five sets of columns in the accounting part of the record. The first set deals with the number of castings ordered through the purchasing department. The first column in this set is headed "Requisition Number," and in it is entered the number of the requisition which the castings clerk makes on the purchasing department when he finds it necessary to order castings. The second column is for the date of the requisition, the fourth column for the quantity called for by the requisition, and the third column for the purchase order number. This third column is filled out when the castings clerk receives back from the purchasing department an extra carbon of his requisition with the purchase order number on it. So long as this third column is vacant it shows that the purchasing department has not placed the order for the castings. This may be due to negotiations with foundries or to new pattern or change in pattern.

The second set of columns is a record of castings received. Postings are made in this set of columns from the receiving department's reports of castings received. The third set of columns is a record of castings reserved for production orders which make a draft on the stock of castings. Reservation entries are made in these columns from the stores department copy of each production order. Whenever production orders are finished, the tags which accompanied the finished goods through the inspection department are sent to the stores office. The clerks in the stores department use these tags bearing the inspector's stamp as their authority for canceling the numbers referring to live production orders. In this way only those numbers which do not have lines drawn through them represent production orders which are still in process of manufacture. The fourth set of columns is a record of castings used, and is posted from the castings warehouse-man's receipt forms for castings drawn from his department. The fifth set of columns is a record of the actual balance on hand in the warehouse, together with the balance after deducting castings in reserve for use on production orders already issued, but for which the castings have not yet been taken from the castings warehouse. The balance by actual count can conveniently be reported for all castings of which the stock on hand does not exceed 10 or 15, every time a withdrawal is made, such balance by actual count being noted on castings ware-



CASTINGS

CARD No.
NAME OF PART
FOR

MIN.
PUR. QT.
MAX.
BIN No.
TIME

PAT. No.
MATERIAL
MARK No.
DR'W'G No.
AV. WT.

ORDERED				RECEIVED			RESERVED			USED			IN STOCK		
REQ. NO.	DATE	ORDER NO.	QUANTITY	DATE	ORDER NO.	QUANTITY	DATE	ORDER NO.	QUANTITY	DATE	ORDER NO.	QUANTITY	DEDUCTING IN RESERVE	DATE	ON HAND

FIG. 74.—Form for perpetual inventory of castings, together with record of requirements for production and shipping orders. Buff-colored card, 8 3/4 inches wide, 5 1/2 inches high, ruled in red and blue.

house-man's receipts for castings issued when he turns them in to the castings record clerk. For castings of which a considerable number in excess of 10 or 15 are carried, the castings warehouse-man makes a systematic practice of making actual counts and reports in the intervals which he has between issuing, receiving, and arranging castings in the warehouse. In this way balances by actual count can be continuously turned in on a considerable number of castings, so that there is a constant checking and correcting of the castings clerk's records by actual inventory. Such checking will be found almost indispensable, as the fallibility of stock clerks and castings warehouse attendants is far more common than infallibility of records. When discrepancies are discovered there is no need for internal dissension. It is desirable, however, that some person in authority make a careful and possibly secret investigation in case there appears to be a continual shortage of the more valuable kind of castings, such as those made of copper and brass.

The castings warehouse will usually have to be equipped with hoists or cranes for handling heavy castings. Trolley tracks for hoists running into the aisles between the bins will be found convenient, and for extra heavy castings room may be provided underneath a crane constructed of an I-beam with a circle track, a hoist running radially along the I-beam. This arrangement makes it possible to cover any point within the circle. If the shelves and other storage places become crowded, it may be policy to retire to outdoor storage such castings as appear to be becoming obsolete. As a general rule, it is best, however, to keep all castings under cover except where a special point is to be made of accumulating a coating of rust for the purpose of making the first machining easier.

The records for raw material other than castings and for purchased finished parts may take practically the same form as the castings record shown.

199. Perpetual Inventory of Manufactured Parts.—The record covering manufactured finished parts will usually have to be kept in a somewhat different form from the records covering the castings as already described.

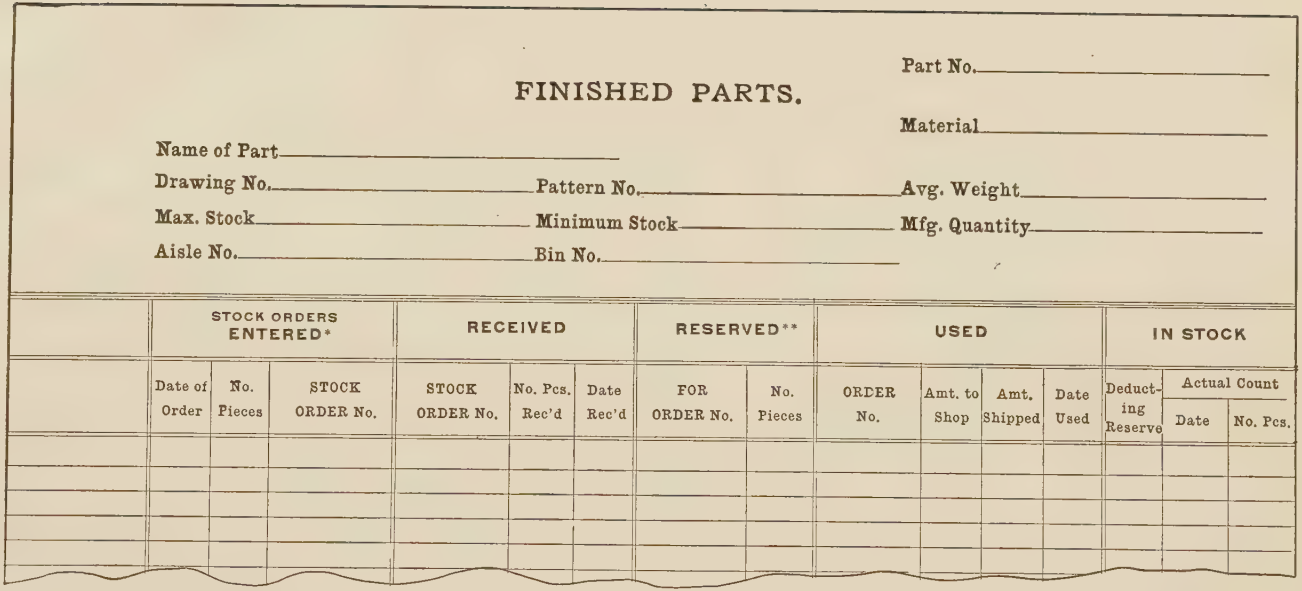
A form for keeping record of manufactured finished parts is shown in Fig. 75. In the upper right-hand corner are stated the part number and the material of which the part is made. In addition to these data the sheet or card specifies the name of the part, the drawing number, the pattern number if the piece is made from a casting, the maximum and minimum stock, the manufacturing quantity, also the location of the stock of finished parts in the finished parts warehouse.

The accounting part of the finished manufactured parts record is divided into five groups of columns.

The first group of columns is a record of stock orders entered, giving the date of the production order, the number of pieces, and the shop-order number. The second set of columns is a record of the number of finished pieces received by the finished parts warehouse-man from the shop (usually through the inspection department), giving the production order number, the number of pieces received, and the date they were received. As soon as a production order listed in the first set of columns is completed, as shown by the finished parts having been received by the finished parts warehouse-man, a line is drawn through that stock order number in the first set of columns. In this way the live unfinished orders for parts will always be those through which no lines are drawn.

In any shop it is likely that the tag or other form of identification which accompanies the pieces through the shop may become accidentally lost, or pieces may be taken from lots of work in progress through ignorance or intentional violation of the shop system by men in assembling, erecting, shipping, or other departments, thus causing an apparent shortage or discrepancy. Whenever an order in the first set of columns, therefore, looks suspiciously old, or when it is suspected that the number of pieces turned into finished parts warehouse, though not the entire lot, is likely to be all the pieces that will be turned in on the order in question, it will be desirable for the head of the manufactured finished parts records to start an investigation through the proper channels with a view to striking off his records any orders as dead or completed for which the material cannot be found in the shop. This sort of condition should happen very rarely in a well-managed shop, and it is important that every case of this sort be most carefully traced with the end in view of discovering who was responsible for the irregularity.

The third set of columns is a record of the reservations of finished manufactured parts called for by bills of material and supply shipment orders. Entries in this column are canceled as soon as the parts are actually withdrawn, as shown by the ware-



FINISHED PARTS.

Part No.__________

Material__________

Name of Part__________

Drawing No.__________ Pattern No.__________ Avg. Weight__________

Max. Stock__________ Minimum Stock__________ Mfg. Quantity__________

Aisle No.__________ Bin No.__________

	STOCK ORDERS ENTERED*			RECEIVED			RESERVED**		USED				IN STOCK		
	Date of Order	No. Pieces	STOCK ORDER No.	STOCK ORDER No.	No. Pcs. Rec'd	Date Rec'd	FOR ORDER No.	No. Pieces	ORDER No.	Amt. to Shop	Amt. Shipped	Date Used	Deducting Reserve	Actual Count	
														Date	No. Pcs.

* Cancel Entries in these Columns as soon as all parts called for have been received or used.
** Cancel Entries in these Columns as soon as parts are actually withdrawn.

FIG. 75.—Form for perpetual inventory of finished parts, together with record of requirements for production and shipping orders. White linen paper, 9 1/2 inches wide, 11 inches high, ruled in red and blue.

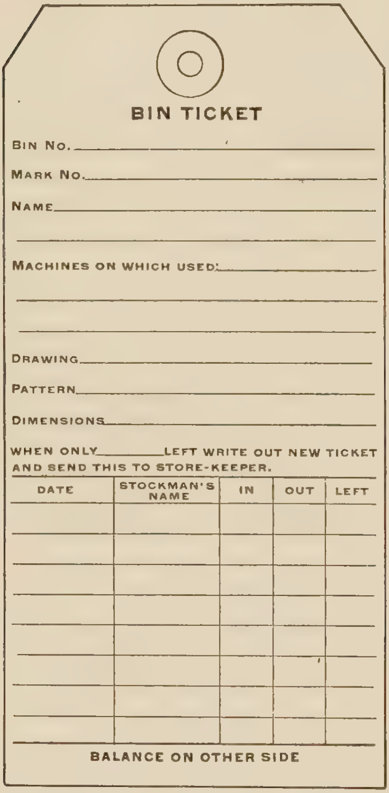
house withdrawal's receipts, which are turned in daily to the finished parts clerk, who passes them on to the cost department.

The fourth set of columns is a record of parts withdrawn, posted from the finished parts warehouse withdrawal receipts already mentioned. The first column gives the order number, which may be either a "Bill of Material" order, on which the shop draws parts for assembling purposes, or a shipping order for supply parts. If the former, the number delivered to shop is entered in the second column in this group. If the pieces were shipped, they are entered in the third column, headed "Amount Shipped." The last column in this group states the date the pieces were used.

The last group of columns is the final record of actual balance in stock, the first column giving the balance, deducting those in reserve, and the last column the actual count in the warehouse. This actual count is checked up from time to time in precisely the same manner as in the castings warehouse. Where the stock is not too great to make it a hardship to make an actual count every time a lot is received from the shop, such actual count is made and the balance by actual count noted by the storekeeper of the finished parts warehouse on his reports to the record clerk of finished parts.

200. Bin Tickets.—A bin-ticket record system will also facilitate the keeping up of an accurate record in the warehouse itself. Another reason for using a bin ticket is that each stockman can be required to enter his initials on the bin record every time he withdraws stock, and in this way he can be held to accuracy and prevented from taking an excess of small parts and letting the surplus lie around the packing-room. The bin ticket cannot usually be made to serve as the record of stock on hand, such as is kept by a regular stock-record clerk, because the records for quick reference and entering must be in compact form. However, the bin ticket has a salutary disciplinary effect, besides being useful in posting new stockmen as to the correct names of stock.

A form for bin ticket is shown in Fig. 76. This ticket bears spaces for the number of the bin, the mark number of the piece, the name of the piece, the machines on which the piece is used, the drawing number, pattern number, and dimensions. Also a statement of the minimum stock as follows: "When only...... left, write out new ticket and send this to storekeeper." Below the above heading is the record part of the ticket, printed on both sides, with a column for date, a column for stockman's name or initials, and columns headed, "In," "Out," and "Left."



BIN TICKET

BIN No. __________

MARK No. __________

NAME __________

MACHINES ON WHICH USED: __________

DRAWING __________

PATTERN __________

DIMENSIONS __________

WHEN ONLY ______ LEFT WRITE OUT NEW TICKET AND SEND THIS TO STORE-KEEPER.

DATE	STOCKMAN'S NAME	IN	OUT	LEFT

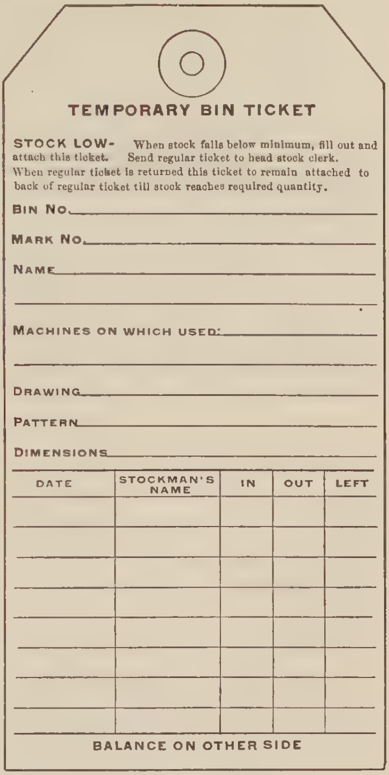
BALANCE ON OTHER SIDE

Fig. 76.—Form for bin ticket in storeroom recording actual receipts and withdrawals. Manila tag with reinforced eyelet, 3 1/8 inches wide, 6 1/2 inches high.

Fig. 77 shows a form for a so-called "Temporary Bin Ticket." In the system in which this was used, the regular bin ticket was sent to the head stock clerk as soon as the stock reached the minimum, and at the same time a "Temporary Bin Ticket" was fastened to the bin. This temporary bin ticket bears the same heading and record form as the regular bin ticket, with the following instruction memorandum in addition: "Stock Low—When stock falls below minimum, fill out and attach this ticket. Send regular ticket to head stock clerk. When regular ticket is returned, this ticket to remain attached to back of regular ticket till stock reaches required quantity." The color of the "Temporary Bin Ticket" is salmon, so that as any person in authority goes through the warehouse, he can tell by the salmon-colored tag being attached to a bin that the stock is below the minimum. If only the salmon-colored tag is attached, it shows that the matter is being taken up by the head stock clerk. If both the salmon-colored tag and the regular tag are attached, it shows that the stock clerk has investigated the matter and has arranged it to his evident satisfaction; but so long as the salmon-colored tag remains at the bin it shows that the stock is not yet up to the required minimum.

201. "Finding Lists."—It is very essential that finding lists be provided in the finished parts and castings warehouses. Such finding lists may be in the form of card records. For convenience there should be one set arranged by consecutive mark numbers in the case of finished parts, and by consecutive pattern numbers in the case of castings, together with the corresponding bin number or other statement of location; also another record arranged alphabetically by the name of the part. In this way it is easy to find promptly the location of any items. Such finding lists should be located near the entrance to the stock warehouse. If there are several floors, it may be found a saving of time and labor to have more than one finding list in the warehouse.

202. Numbering Storeroom Bins.—The best way to number bins in stock warehouses is to divide the whole cubic volume of the house into spaces, and allot a certain number of spaces to each volume, whether the volume is to contain large or small bins. In this way, no matter what changes or rearrangements in the sizes of the bins there may be, the same number will always designate the same space in the warehouse. For instance, all bins in the 10,000 series would represent bins in aisle 10, those beginning with 10,500 representing the bins on one side of the aisle, and those beginning with 10,000 the bins on the opposite side of the aisle. If the bins are large, of course a good many numbers will not be



TEMPORARY BIN TICKET

STOCK LOW— When stock falls below minimum, fill out and attach this ticket. Send regular ticket to head stock clerk. When regular ticket is returned this ticket to remain attached to back of regular ticket till stock reaches required quantity.

BIN NO. ____

MARK NO. ____

NAME ____

MACHINES ON WHICH USED: ____

DRAWING ____

PATTERN ____

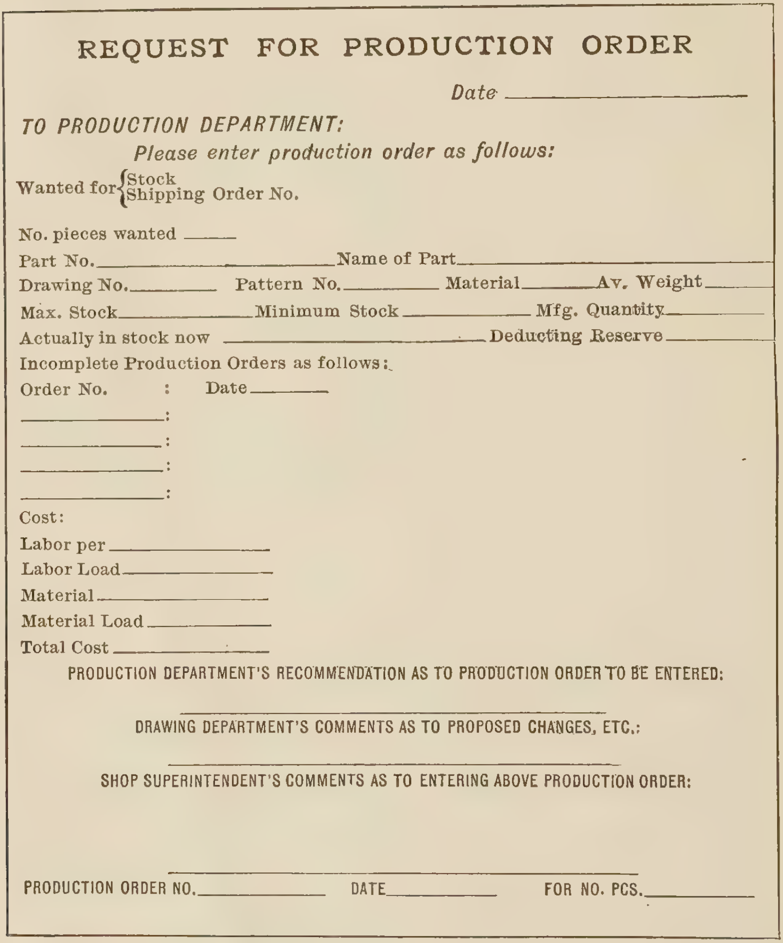
DIMENSIONS ____

DATE	STOCKMAN'S NAME	IN	OUT	LEFT

BALANCE ON OTHER SIDE

Fig. 77.—Form for temporary bin ticket printed on salmon-colored or other distinguishing tag stock to call attention to the fact that quantity is under the low limit. Salmon-colored tag with reinforced eyelet, 3 1/8 inches wide, 6 1/2 inches high.

used. This is practically the same principle that has been finally adopted as the most satisfactory method of numbering houses in city streets, and will be found equally satisfactory in storage warehouses.



REQUEST FOR PRODUCTION ORDER

Date ____________

TO PRODUCTION DEPARTMENT:

Please enter production order as follows:

Wanted for {Stock / Shipping Order No.

No. pieces wanted ____

Part No. ____________ Name of Part ____________

Drawing No. ______ Pattern No. ______ Material ______ Av. Weight ______

Max. Stock ______ Minimum Stock ______ Mfg. Quantity ______

Actually in stock now ____________ Deducting Reserve ______

Incomplete Production Orders as follows:

Order No. : Date ______

________ :

________ :

________ :

________ :

Cost:

Labor per ________

Labor Load ________

Material ________

Material Load ________

Total Cost ________

PRODUCTION DEPARTMENT'S RECOMMENDATION AS TO PRODUCTION ORDER TO BE ENTERED:

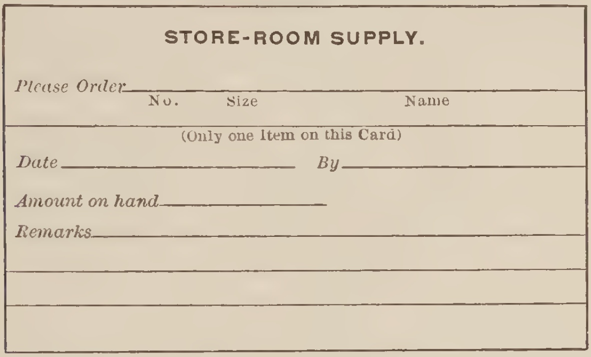
DRAWING DEPARTMENT'S COMMENTS AS TO PROPOSED CHANGES, ETC.:

SHOP SUPERINTENDENT'S COMMENTS AS TO ENTERING ABOVE PRODUCTION ORDER:

PRODUCTION ORDER NO. ________ DATE ________ FOR NO. PCS. ________

FIG. 78.—Stores record clerk's request for production order. This request may emanate also from other sources. White bond paper, 8 1/2 inches wide, 10 1/2 inches high.

203. Replenishment of Stores.—Reference has been made to minimum stock and manufacturing quantities in connection with the records of finished parts and of castings. It is not usually wise to have these figures serve any other purpose than as guide to the stock record clerks, to notify them that they must send in the notice of the low condition of stock to the person or department in charge of production. One method of sending in such notice might be to send in the stock sheet or card direct to the person or department in charge of production. However, this method results in the stopping of posting work on the stock sheets or cards, and is likely to be an unsatisfactory method in the long run. A better scheme is one of sending a notice to the production manager or production department, giving all the information contained on the heading of the stock sheet, and also complete information as to the unfinished orders, the balance in stock, number in reserve, etc. Fig. 78 is a form of such notice or request.



STORE-ROOM SUPPLY.

Please Order ______
No. Size Name

(Only one Item on this Card)

Date ______ *By* ______

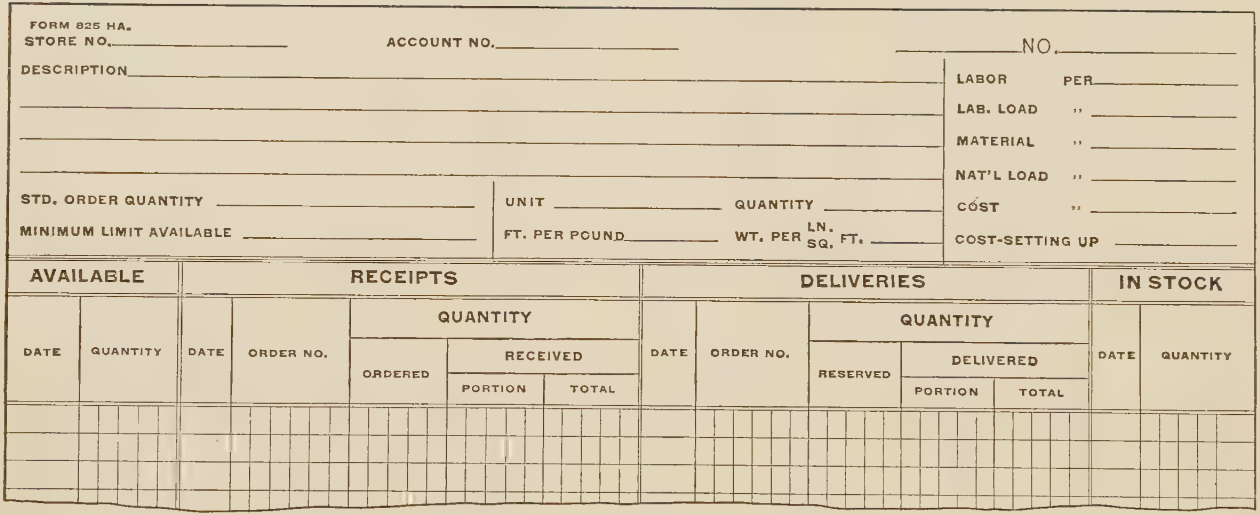
Amount on hand ______

Remarks ______

Fig. 79.—Storeroom request to head storekeeper for replenishment of parts or supplies. Orange-colored bond paper, 5 inches wide, 3 inches high.

A form to be used by stores department in making requisition on the head of that department in replenishing stores is shown in Fig. 79. On receipt of this requisition or notice, the head of the department issues requisition on purchasing department similar to Fig. 69.

This request for replenishment coming from the storeroom may at first sight appear like a superfluity in view of the fact that the stores record clerks have records which indicate when the low limit is reached. However, it is a double precaution to have the storeroom send in such a request for replenishment and in practice it will be found desirable, as an error or oversight on the part of the stores record clerks in allowing stores of a cer-



FORM 825 HA.
STORE NO.__________ ACCOUNT NO.__________ ________NO.________
DESCRIPTION__________
STD. ORDER QUANTITY ________ UNIT ________ QUANTITY ________
MINIMUM LIMIT AVAILABLE ________ FT. PER POUND________ WT. PER LN. SQ. FT. ________

LABOR PER________
LAB. LOAD ,, ________
MATERIAL ,, ________
NAT'L LOAD ,, ________
CÓST ,, ________
COST-SETTING UP ________

AVAILABLE		RECEIPTS					DELIVERIES					IN STOCK	
DATE	QUANTITY	DATE	ORDER NO.	QUANTITY			DATE	ORDER NO.	QUANTITY			DATE	QUANTITY
				ORDERED	RECEIVED				RESERVED	DELIVERED			
					PORTION	TOTAL				PORTION	TOTAL		

FIG. 80.—Stores record card showing value of each unit in money, as required in a complete stores accounting system. White card, 8 1/2 inches wide, 12 inches high, ruled in blue, red, and green.

tain item to get too low are in this manner caught by the storeroom help.

204. Monthly Balances Showing Money Value as well as Quantity of Stores.—The stores and stock record sheets described heretofore afford means for knowing at any time the balance on hand of all materials. Should it be desired to express the value of this material in dollars and cents, as will be the case at inventory time, or as is the case in companies making quarterly or monthly statements, it will be found necessary to specify cost data on the stock record sheets or cards. In any event the stock records form a very convenient place for having these costs, because then the costs are available and ready for use, and found in the same place as the balances on hand. Fig. 80 is a typical card used in a system in which monthly statements are made. The upper right-hand corner of the record gives full data as to manufacturing costs.

MONTHLY COMPARISON OF STOCK MATERIAL BALANCES.

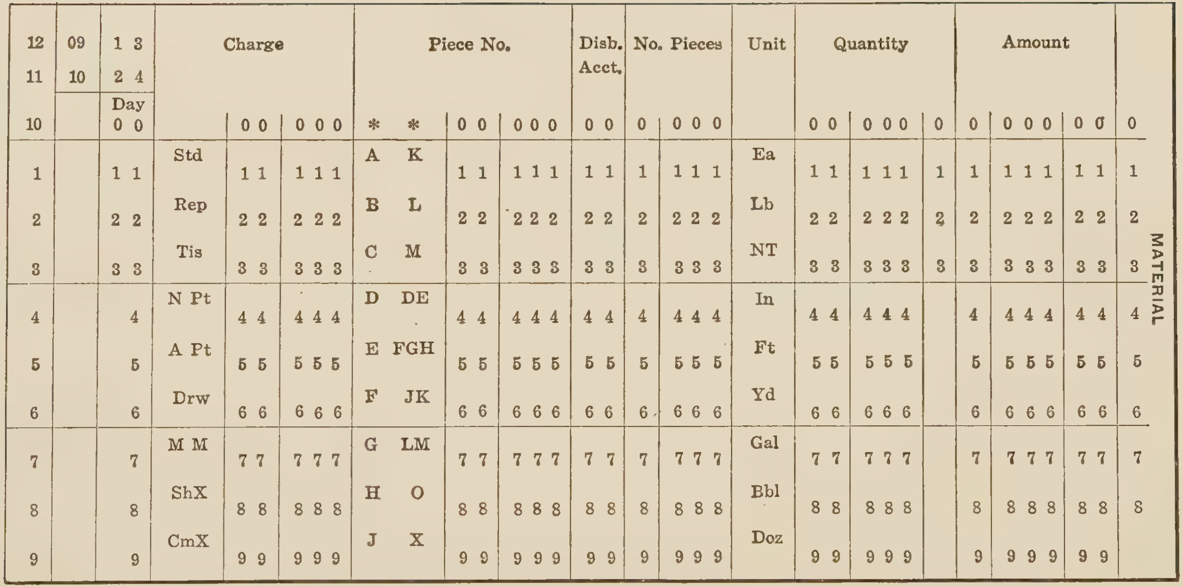
MONTH OF September, 1909

CLASS OF MATERIAL	Month of Sept. 1909	Compared with Month of Aug. 1909	Increase	Decrease
Axles	820.49	620.35	200.14	
Bearings	615.26	600.15	15.11	
Bolts and Nuts	2126.15	2237.26		111.11
(*etc.*)				

FIG. 81.—Monthly comparison of money value of leading material balances. White bond paper, 8 1/2 inches wide, 10 1/2 inches high.

It may be found desirable to collect various material items into groups and compare the money value of the monthly balances, showing increase or decrease in each class. Fig. 81 shows a form used for this purpose.

205. Use of Tabulating Machine in Obtaining Money Value of Daily Material Receipts and Disbursements.—Fig. 82 shows a tabulating machine punch card for transcription of storeroom



12 11	09 10	1 3 2 4	Charge			Piece No.			Disb. Acct.	No. Pieces		Unit	Quantity			Amount			MATERIAL
10		Day 0 0		0 0	0 0 0	* *	0 0	0 0 0	0 0	0	0 0 0		0 0	0 0 0	0	0	0 0 0	0 0	0
1		1 1	Std	1 1	1 1 1	A K	1 1	1 1 1	1 1	1	1 1 1	Ea	1 1	1 1 1	1	1	1 1 1	1 1	1
2		2 2	Rep	2 2	2 2 2	B L	2 2	2 2 2	2 2	2	2 2 2	Lb	2 2	2 2 2	2	2	2 2 2	2 2	2
3		3 3	Tis	3 3	3 3 3	C M	3 3	3 3 3	3 3	3	3 3 3	NT	3 3	3 3 3	3	3	3 3 3	3 3	3
4		4	N Pt	4 4	4 4 4	D DE	4 4	4 4 4	4 4	4	4 4 4	In	4 4	4 4 4		4	4 4 4	4 4	4
5		5	A Pt	5 5	5 5 5	E FGH	5 5	5 5 5	5 5	5	5 5 5	Ft	5 5	5 5 5		5	5 5 5	5 5	5
6		6	Drw	6 6	6 6 6	F JK	6 6	6 6 6	6 6	6	6 6 6	Yd	6 6	6 6 6		6	6 6 6	6 6	6
7		7	M M	7 7	7 7 7	G LM	7 7	7 7 7	7 7	7	7 7 7	Gal	7 7	7 7 7		7	7 7 7	7 7	7
8		8	ShX	8 8	8 8 8	H O	8 8	8 8 8	8 8	8	8 8 8	Bbl	8 8	8 8 8		8	8 8 8	8 8	8
9		9	CmX	9 9	9 9 9	J X	9 9	9 9 9	9 9	9	9 9 9	Doz	9 9	9 9 9		9	9 9 9	9 9	

FIG. 82.—Tabulating machine punch card for transcription of store-room records of receipts and disbursements. Dimensions approximately 3 1/4×7 1/2 inches.

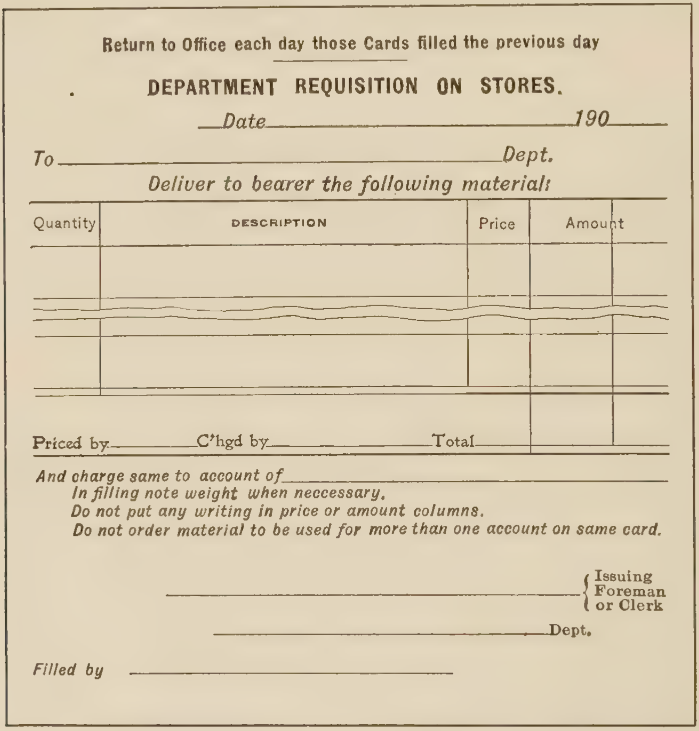
records of receipts and disbursements of materials. In order to use a working card in the tabulating machine it is necessary to designate everything numerically, the record being formed by punching the digits in columns of figures printed on a card, such punching being done on a special machine made by the Hollerith Tabulating Machine Co. The punching may be done as a transference of records written originally in pencil on other slips.

The punched tickets are put first into an assorting machine which classifies them by the same numbers in any one column, for instance, material-tickets may be assorted by departments, by piece number, by quantity, by order numbers, etc., depending upon which column is being used for the purpose of assorting. After the assorting process is accomplished at a very rapid rate by the machine the cards are transferred to the accumulating or adding machine, which adds up the hours and minutes or dollars and cents for any package of cards.

206. Withdrawing Materials from Stores.—In connection with the drawing of needed material from stores, there will be necessary some form of requisition on the storekeeper. Usually the tag which accompanies a stock order of individual parts through the shop is provided with a coupon which serves as an order and receipt for the necessary material, so that no requisition is needed to get the material for this class of order.

In general, a well-organized planning or production department provides ready-written in advance, all necessary material withdrawal slips, these being considered as essential a feature of planning as the blue-prints.

There will, however, be repair orders, assembling and erecting orders, etc., which necessitate the getting of material from the stores warehouse. For this purpose a requisition on stores similar to Fig. 67 must be used. Fig. 83 shows an additional form used for this purpose. This form, after passing through the hands of the head storekeeper, is sent to the cost department, which prices it in some companies. In other companies the stores record clerks insert the prices from their records. The cost department refers back to the department making the requisition any calls for material which seem to be in excess of requirements or in error. Systems have been tried whereby only one issuance of material for a given order will be made to the shop, and only such material issued as is called for by the bill of material. As a general rule it is better policy to issue material when called for by a responsible department foreman, and adjust later any discrepancies between bills of material or other specifications and foreman's statement as to his requirements.



Return to Office each day those Cards filled the previous day

DEPARTMENT REQUISITION ON STORES.

Date ________________ *190* ____

To ____________________ *Dept.*

Deliver to bearer the following material:

Quantity	DESCRIPTION	Price	Amount

Priced by ________ C'hgd by ________ Total ________

And charge same to account of ________________

In filling note weight when neccessary.

Do not put any writing in price or amount columns.

Do not order material to be used for more than one account on same card.

________________ Issuing Foreman or Clerk

________________ Dept.

Filled by ________________

Fig. 83.—Another form for requisition on storeroom. (See also Fig. 67.) Manila card, 4 inches wide, 6 inches high.

Under no circumstances should production be stopped pending adjustment of technicalities as to quantity of material.

REFERENCES

Going: "Methods of the Santa Fe," Chapter II.
Going: "Principles of Industrial Engineering," Chapter IX.
Ennis: "Works Management," Chapter V.
Cook: "Factory Management," Chapters VII and VIII.
Parkhurst: "Applied Methods of Scientific Management," Chapter V.

CHAPTER XVII

THE PRODUCTION OR PLANNING DEPARTMENT

207. Functions of Production or Planning Department.—In our discussion of the routine work of an industrial establishment, as distinct from the staff functions, we have seen how the general office takes care of the correspondence, how the order department enters and records the customers' orders, how the bill-of-material department lists all component parts, how designing, drafting, and pattern departments, respectively, take care of all new designs, drawings, and patterns, and how the various stores record clerks put in requisitions for purchase orders for purchased items which are needed, and make requisitions for production orders to make the parts that have to be manufactured in the shop. If the above-mentioned departments are well conducted, there is no danger of the necessary material and parts not being duly ordered. It now remains to put this work through the shop in the most effective way.

In many establishments the order department which enters the customers' orders also writes out the shop production orders on authorization of the shop superintendent or head stock-keeper. In other establishments the stock clerks are delegated the authority to issue production orders for all parts made in quantity lots. The most satisfactory arrangement, however, is that in which the scheduling or dispatching or order of precedence of shop orders, the designating of order of work to be done by each man and machine, the routing, the supplying of the necessary instruction cards, tool lists and blue-prints with the shop orders, and the tracing and following up of all shop orders, is handled by a single department. The older and more widely used name of this department is the production department. To a certain extent this name is a misnomer, as the department does not supervise the technical execution of the work. Hence we find the name "Dispatching Department" used in some instances. More lately the term "Planning Department" has come into general use. Some of the well-known experts in shop management have included in the Planning Department the stock records and cost-keeping. For instance at the Ferracute Machine Co., where Mr. Frederic A. Parkhurst installed methods of management closely modeled after Dr. Taylor's methods, the Planning Department includes the following sub-department heads:

a. Production Clerk.
b. Shop Engineer.
c. Stores Clerk.
d. Cost Clerk.
e. Route Clerk.
f. Order-of-work Clerk.
g. Shipping Clerk.
h. Receiving Clerk.
j. Time Clerk.
k. Schedule Clerk.
l. Factory Mail Clerk.
m. Time Clerk.
n. Inspector.
o. Stores Keeper.
p. Move Material Boss.

The above arrangement is unquestionably effective in centralizing the needed authority to secure results in the head of a Planning Department, where an expert consultant is engaged to install a Planning Department and must have the authority to get results. I prefer to consider the above comprehensive list of sub-departments all merged under one department as a transitional arrangement only. The chapter headings in this book indicate my preference based on experience as to demarcation of departmental lines. A production department in my opinion can be developed into a higher state of permanent efficiency if it does not include stock records and cost-keeping, than if it does carry these branches also. To be sure the Cost Department and the Stores and Stock Records must be closely adjacent to the Production Department, and all of these departments may advantageously be under the jurisdiction of an Assistant Works Manager, whose authority may cover all the clerks or sub-departments named in Mr. Parkhurst's list.

The production, or dispatching, or planning department came in answer to a call for help from the business owners and managers of industrial establishments who were becoming nervous wrecks because of the need of constant running from one department to another for information which could only be half given. They began to realize that the cost of their own time and energy, and the lost time of the army of emissaries they were constantly sending to the shop, amounted to a large financial aggregate.

The absolute knowledge of the condition of the manufacturing department—its percentage of uncompleted work, the condition of this work, and the factory's capacity for further orders—has a financial value. The cost of production has been shown to be lowered after shops have instituted a well-managed production department. More than this; after some months' running of the production department, the work of the office, sales department, time-keepers, correspondents, shipping department, and cost clerks has been known to become so much simpler that not only was the operation of these departments much more efficient, but it could be done with less help.

What are the functions and duties of this department? In general, its task is to lay out in detail all work to be done in the factory, to keep perfect record of progress of work on all orders, and to see that foremen and other executive officers are kept closely advised of all conditions requiring their special attention. It will readily be seen that by centering all of the record and statistical routine into a distinct department, foremen and superintendents are left far more free to do real executive work than under the old-fashioned systems in which they carried the entire burden of recording and following up all work in a shop.

In the majority of shops to-day the production record follows the actual production. There is no systematic issuing of detail jobs in advance. An effective shop production system always involves the writing out in detail of all jobs and the specifying of all operations or "routing" necessary to complete every item, together with instructions as to the details of each operation.

The providing of such an advance stock of job order tickets, and furnishing them to the shop, with definite instructions as to the sequence in which the jobs are to be worked on, enables foremen to plan and lay out their work, providing they have the ability to do this—an essential quality to a good shop foreman. A well-managed production department is of great assistance to a foreman in making such plans.

Without such a department it is next to impossible for department foremen to keep their orders and work in systematic shape. From this results delay in getting out orders; failure to discover shortages or incompleteness until a piece of work is ready for shipment; inaccurate time and cost returns, and general looseness of methods.

208. Qualifications of Head of Production or Planning Department.—The man at the head of the production department must be a man of considerable capacity. He must be able to make the best use of recording systems, and at the same time be a man who can see things with his own eyes in the shop. He confers daily with the shop superintendent and brings up all matters in connection with condition of orders, getting out of work, and capacity of the shop, at foremen's meetings held regularly, at which the superintendent is also present. The importance of such foremen's meetings cannot be over-estimated.

The man in charge of the production department needs to be given such intelligent assistance as may be required, to make every job ticket or tag that goes into the shop as clear a guide as possible to foremen, workmen, and time-keepers, and to prevent inaccurate returns to the cost department or other departments. With a well-managed production department there is no need of any clerical work by shop foremen or under their supervision. The production department does away with the necessity for shop clerks and foremen's clerks; neither must the foremen do any clerical work.

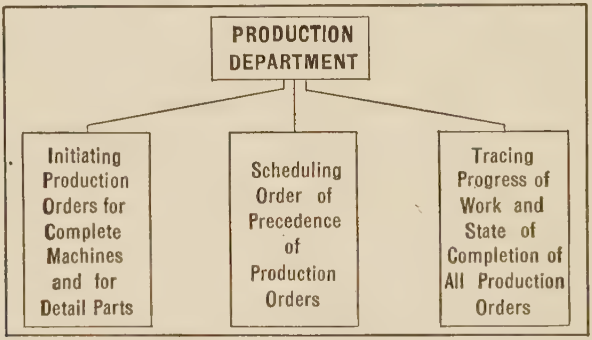

PRODUCTION DEPARTMENT
Initiating Production Orders for Complete Machines and for Detail Parts
Scheduling Order of Precedence of Production Orders
Tracing Progress of Work and State of Completion of All Production Orders

Fig. 84.—Classification of the functions of the production department under three heads as they are usually grouped. Some organizations include time-keeping, time-study, and rate-fixing with these duties.

The head of the production department should have no other duties than those connected with that department, the special functions of which are the tracing of work in progress, the preparing of detailed individual job orders, or routing, preparing instruction cards, fixing time standards, determining the order of precedence of each job (sometimes called scheduling), and the keeping of a record of all work in progress.

209. Relation of Production or Planning Department to Other Departments.—The chart shown in Fig. 84 indicates the functions usually assigned to the production department—although other functions have been added in some establishments, some companies preferring to include time-keeping and time-study, together with rate-fixing, as also parts of the work of a production department.

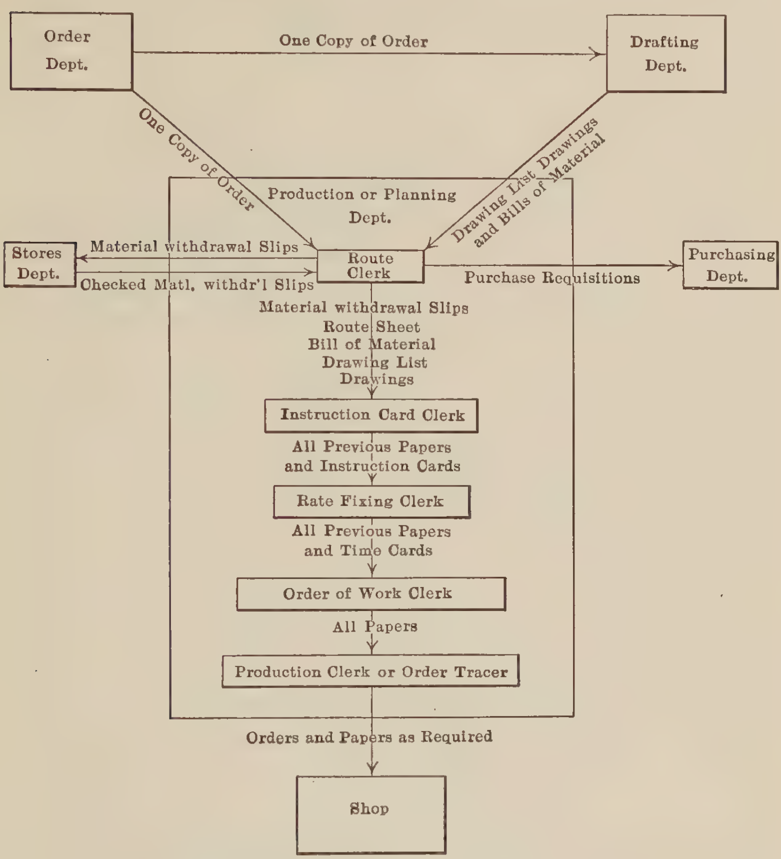

Order Dept.
One Copy of Order
Drafting Dept.
One Copy of Order
Drawings List Drawings and Bills of Material
Production or Planning Dept.
Stores Dept.
Material withdrawal Slips
Checked Matl. withdr'l Slips
Route Clerk
Purchase Requisitions
Purchasing Dept.
Material withdrawal Slips
Route Sheet
Bill of Material
Drawing List
Drawings
Instruction Card Clerk
All Previous Papers and Instruction Cards
Rate Fixing Clerk
All Previous Papers and Time Cards
Order of Work Clerk
All Papers
Production Clerk or Order Tracer
Orders and Papers as Required
Shop

FIG. 85.—Relation of production or planning department to other departments, and path of an order through the production department.

The production department is not intended in any way to lessen the power of the shop superintendent. It is intended to relieve the superintendent, and to assist him by constituting a certain place of responsibility for accurate knowledge as to all matters of production. When thus fully posted, the superintendent is free to use his executive authority, and to be often about the shop. The responsibility of tracing and keeping before the superintendent and foremen all matters of precedence and urgency rests wholly with the production department. Many shops throw this responsibility on a variety of persons connected with the sales, correspondence, and general office management, resulting in a multiplicity of bosses and considerable useless running around.

That it may work to best advantage, it has been found desirable to take the shop production department from under jurisdiction of the shop superintendent. By this arrangement the department has no hesitancy or timidity about keeping strongly after any delays or failures to realize promises or estimates.

Fig. 85 shows in detail the relation of the Production Department to other departments. It shows how the Order Department sends one copy of the order to the Drafting Department, and one copy of the order to the Production Department. The Drafting Department sends the drawing list, drawings and bills of material to the Production Department. The particular individual in the Production Department who receives the orders from the Order Department and the papers designated from the Drafting Department is the Route Clerk.

210. Routing.—The route clerk makes up a route chart for every order. In case the order is for a machine, he lays out the chart so as to show what groups must be completed before general assembly or erecting can take place. He also indicates what pieces must be completed before any one group can be assembled. He must be familiar with the equipment and processes of the shop, and should have at hand general process maps and models of the shop showing departmental lay-outs and equipment. The drawings, drawing lists and bills of material which he receives from the drafting department aid him in preparing his route chart.

The route clerk, on receipt of the bill of material from the drafting department writes out or has an assistant write out the withdrawal slips or orders on storeroom for any needed materials. These he forwards to the stores department where the stores record clerk or balance of stores clerk, as he is sometimes called, checks the requirements up against his perpetual inventory and designates what production orders need to be entered for

The Penn. State College. *Industrial Engineering Dept.*

Instruction Card for Students. *Sheet No.* 1.

Description of Operation, Laying out Centers and Turning Eccentric.

Name of Exercise. *Eccentric.* *Drawing No.* 503

Item	Detailed instructions	Time
1	Change cards.	
2	Learn what is to be done.	
3	Chip fins or gate from casting.	
4	Grind scale from end of piece.	
5	Get V blocks and place on surface plate.	
6	Put piece in V blocks.	
7	Chalk ends of piece.	
8	Find approximate center with surface gage.	
9	Scribe line across both ends with surface gage. (Say line A).	
10	Use the square and draw line intersecting the scribed one (Say B).	
11	Pass the piece through 180°, square line B with square.	
12	Scribe second line on one end lightly (Say line C).	
13	Reset surface gage midway between A and C.	
14	Scribe a sharp line across both ends (Say line E).	
15	Turn piece through 180°.	
16	Make line A come straight with square.	
17	Scribe line across both ends of piece.	

FIG. 86.—First page of a "typical Instruction Card." 8 1/2×10 1/2 white mimeograph paper.

quantity manufacture of small parts, together with the manufacturing quantity. The balance of stores clerk also indicates what requisitions for purchased material should be issued, and sends the material order slips, with the information indicated, back to the Route Clerk. In this way all orders on storeroom are written out in correct form beforehand, and mechanics do not lose any time in writing out such orders or waiting for them to be written. These orders and all other papers referred to as having come from the drafting department and referred to hereafter as being written out in the production department are stored in a portfolio of fiber-board paper in which pockets of proper size are prepared to hold every type of paper necessary for the order.

The Penn. State Collage Industrial Engineering Dept.
Tool List Drawing No. 503
Description of Operation. Laying Out Centers and Turning Eccentric

Pieces	Name	Size	Tool Symbol
	Note: This exercise must be drilled and countersunk on speed lathe equipped for this purpose.		
1	Surface gauge	12″	M.G.U.S.
1	Square	6″	M.L.T.
2	V Blocks		C.S.V.
1	Dividers	6″	M.C.D.S.
1	Scale	6″	M.S.S.
1	Carrier	1¾″	C.C.S.N.
1	Turning Tool	⅝″	P.R.S.C.
1	Side ››	⅝″	P. U.S.G.
1	Finishing ››	⅝″	P. S.F.

Fig. 87.—Typical "tool list" to accompany "instruction card." 8 1/2× 10 1/2 white mimeograph paper.

211. Instruction Cards.—The route clerk passes all papers connected with the order over to the next individual in the Production Department who has to deal with them—namely, the Instruction Card Clerk. This man must be able to specify in minute detail each step to be taken to perform every operation. He writes out these instruction cards for each piece and every operation, as well as a tool list to accompany each instruction card. He also fills out a work order or time-card for each part of the process that is to be done by a separate workman, and for each work order or time-card he prepares a detailed instruction card as heretofore indicated. He turns the time-cards over to the rate-fixing clerk, together with all other papers in the order portfolio.

Fig. 86 shows an example of the instruction card as used at the Pennsylvania State College Department of Industrial Engineering. Fig. 87 is an example of the tool list that accompanies the instruction card.

212. Rate-fixing or Time Clerk.—This clerk affixes the standard times in which the elementary steps indicated are to be performed, also any premiums, bonuses or piece rates. The non-clerical or research work of rate fixing is described in a later chapter on this subject.

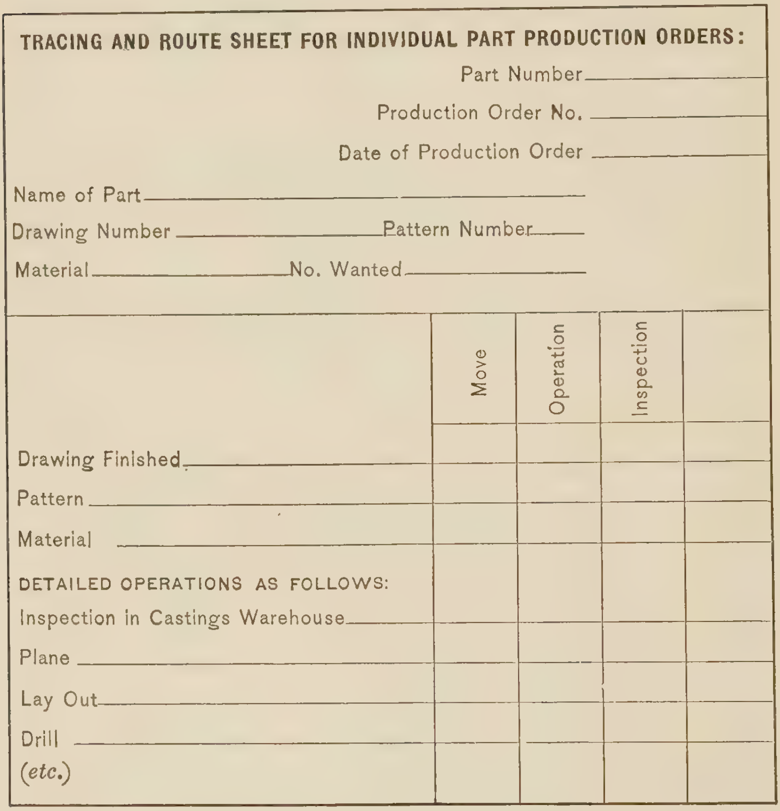
213. Order-of-work Clerk.—The order-of-work clerk receives from the rate-fixing clerk the order portfolio containing all the papers heretofore indicated. He must designate the order of precedence of the various work orders. He has charge of the Main Bulletin Board in the Planning Department office, and the local departmental bulletin boards in the shops, each board bearing hooks on which are cards designating the work for each man and each machine in advance. He sends all papers on to the Production or Tracing Clerk.

214. Production or Tracing Clerk.—This clerk writes out or has assistants write out any tracing tags or follower-books which are to accompany material through the shop. He sees that all the papers he has received go to the proper persons in the shop.

The tracing function of the production department involves the following up of a number of distinct sets of activity by means of records and processes that have to be adapted to each set.

215. Tracing Individual Parts.—A record on which track may be kept of the individual part production orders is shown in Fig. 88. This record is arranged by part numbers and covers only live orders in the shop, a separate tracing record sheet for each separate production order for a given mark number. For instance, there may be three live production orders in the shop issued at various times for stock lots of a given mark number. Then there will be three of these tracing sheets filed back of that mark number.

The tracing sheet bears a heading giving the necessary information as to name of part, drawing number, pattern number,



TRACING AND ROUTE SHEET FOR INDIVIDUAL PART PRODUCTION ORDERS:

Part Number__________

Production Order No. __________

Date of Production Order __________

Name of Part__________

Drawing Number __________ Pattern Number__________

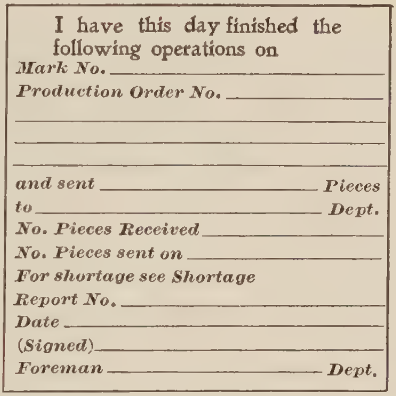
Material__________ No. Wanted__________

	Move	Operation	Inspection	
Drawing Finished__________				
Pattern __________				
Material __________				
DETAILED OPERATIONS AS FOLLOWS: Inspection in Castings Warehouse__________				
Plane __________				
Lay Out__________				
Drill __________				
(etc.)				

Fig. 88.—Form used for keeping record in production department office of progress of each part or lot of components. White bond paper, 8 1/2 inches wide, 11 inches high.

material, and number wanted. It then bears a number of data common to all tracing sheets, concerning the drawing, pattern, and material, after which follows a list of departmental operations or routing which will be different for each piece. Opposite these lists of steps and operations involved in getting out the lot of parts are three columns, headed respectively, "Move," "Operation," and "Inspection." A vertical pencil mark is drawn down through the column headed "Move," as soon as the item has reached the department indicated. As soon as the department has performed its operation, a similar vertical pencil mark is drawn in the "Operation" column, and as soon as the work of that department has been inspected, a similar vertical pencil mark is inserted in the "Inspection" column.

The keeping up of the tracing record involves the standardizing of the routing where possible, though this is not indispensable, and a system of prompt reports of all work finished in each department, which reports can be arranged for by means of perforated coupons on the tracing tag accompanying each lot; or a separate slip may be used notifying the production department or head tracer of each inter-departmental movement of a lot of parts. A form for this purpose is shown in Fig. 89. Another method is to have every workman's change of job approved or clock stamped at the window of an office in which the man in charge of the tracing records receives these time slips every time a man changes jobs.



I have this day finished the following operations on

Mark No. ________

Production Order No. ________

____

____

____

and sent ________ *Pieces*

to ________ *Dept.*

No. Pieces Received ________

No. Pieces sent on ________

For shortage see Shortage

Report No. ________

Date ________

(Signed) ________

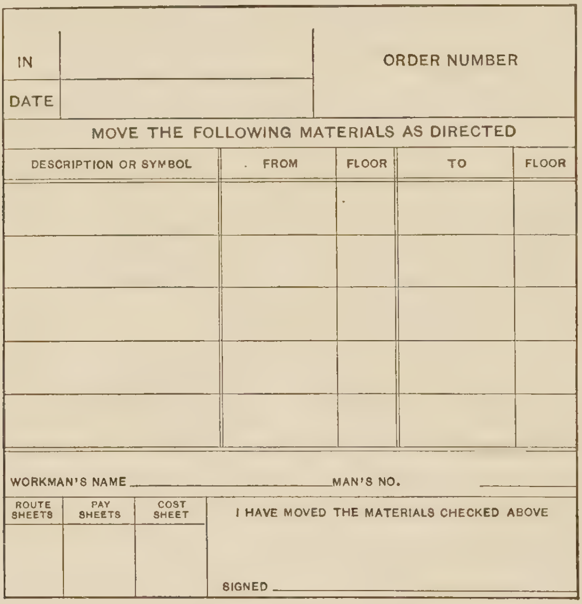
Foreman ________ *Dept.*

FIG. 89.—Foreman's message to tracer in production department. Light green paper, 4 inches wide, 6 inches high.

216. Moving Work in Process.—The jurisdiction over the moving of parts in process from one department to another may be made a function of the production department, such transfer of parts being dependent on separate instruction memoranda, issued to a head stock-mover by means of a form similar to that shown in Fig. 90. This slip tells the head stock-mover from which department he is to take a lot, and to which department he is to deliver it. When he has executed the order given him in this slip, he signs it at the lower right-hand corner after the words, "I have moved the material checked above," and returns the slip to the production department's head tracer or transfer clerk.

Similarly, separate inspection slips may be used for tracing inspection, in case inspection of processes before final completion is the method of inspection employed.

A further refinement of the tracing of the individual production orders which is possible in some shops consists of the securing of a promise date for completion of each operation and awarding a bonus for the highest percentages of living up to estimated dates of completion. The record of total estimated time in any given department, and various deferred promises, may be kept on the bottom of the tracing and route sheet for individual part production orders (Fig. 88), the form being modified so as to carry the additional data. Columns must be provided for the estimates of total hours of labor to do the jobs in any one department, also a column for first promise date of completion and further columns for deferred promises.



IN ____ ORDER NUMBER

DATE ____

MOVE THE FOLLOWING MATERIALS AS DIRECTED

DESCRIPTION OR SYMBOL	FROM	FLOOR	TO	FLOOR

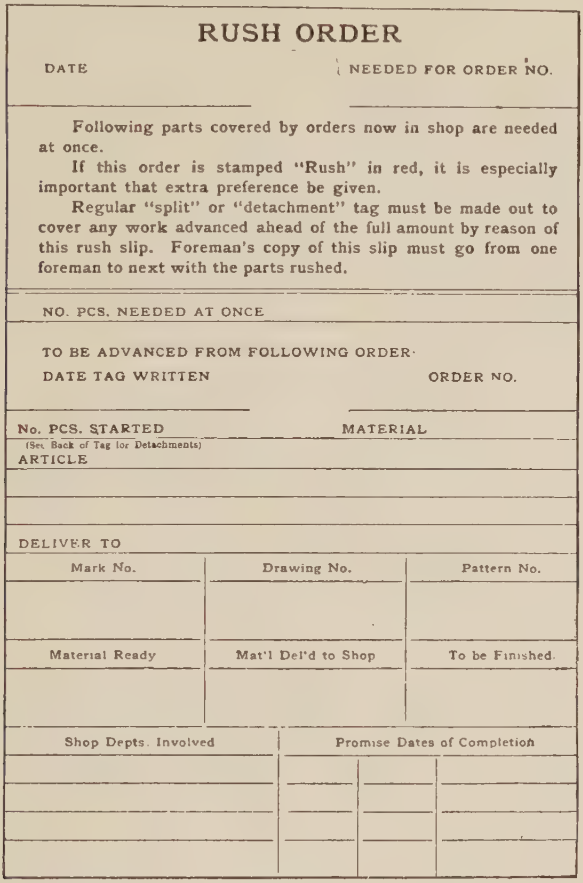
WORKMAN'S NAME ____ MAN'S NO. ____

ROUTE SHEETS	PAY SHEETS	COST SHEET	I HAVE MOVED THE MATERIALS CHECKED ABOVE
			SIGNED ____

Fig. 90.—Instructions from production department to move stock from department to department. Manila card, 4 inches wide, 4 inches high.

217. Rush Orders.—In case it is desired to give especial preference to certain pieces, a "Rush Order" slip similar to Fig. 91 may be used. Such "Rush Order" may be written in duplicate, one set being kept on file in the production department, the other copies going to the shop.

218. Tracing Groups of Parts or Complete Machines.—Thus far the methods described for tracing have referred only to the class of shop orders which call for a quantity of a single piece. The tracing through of an order for one or more completely assembled groups of parts constituting a complete machine or several machines, or other articles consisting of a considerable number of parts, can be taken care of by binding in with



RUSH ORDER

DATE
NEEDED FOR ORDER NO.

Following parts covered by orders now in shop are needed at once.

If this order is stamped "Rush" in red, it is especially important that extra preference be given.

Regular "split" or "detachment" tag must be made out to cover any work advanced ahead of the full amount by reason of this rush slip. Foreman's copy of this slip must go from one foreman to next with the parts rushed.

NO. PCS. NEEDED AT ONCE

TO BE ADVANCED FROM FOLLOWING ORDER·
DATE TAG WRITTEN
ORDER NO.

No. PCS. STARTED
(See Back of Tag for Detachments)
MATERIAL
ARTICLE

DELIVER TO

Mark No.	Drawing No.	Pattern No.
Material Ready	**Mat'l Del'd to Shop**	**To be Finished.**

Shop Depts. Involved	Promise Dates of Completion		

FIG. 91.—Rush order slip sent to shop to hasten one or more pieces being made on a stock order for components. Thin white paper for easy carbon manifolding, 4 inches wide, 6 inches high.

TRACING SHEET.

	TRA-CER ONLY	STORES RECORD DEPT. ENTRIES								CASTINGS AND RECEIVING DEPT. ENTRIES										SHOP TRACER	
	Check each line in this column as soon as item is completely disposed of.	Parts made on Stock Orders to be applied to this B.M.			Purchased Material except Castings					PATTERNS					CASTINGS			TAGS		Draw-ings	Mfg. Parts
		Date of Stock Order	Stock Order No.	No. Pcs. on Stock Order	Date Req'n	Req'n No.	P.D. Order No.	P.D. Order	Date Rec'd in Store Room	Date Req'n	Req'n No.	P.D. Order No.	P.D. Date	Date Pat. Del'd to F'dry	P.D. Order No.	P.D. Order Date	Dates and Amounts del'd from Foundries	Date Tag Written	Date Mat'l Ready	Date Draw-ings in	Date Parts Fin'd

FIG. 92.—Tracing sheet for binding into production department's copies of bills of material covering contract orders or orders for construction of complete machines. Ledger paper, 12 inches wide, 16 inches high, ruled in red and blue.

the bill of material a "Tracing Sheet" form. Fig. 92 is an example of this kind of a form. The first column in this form is headed "Tracer only" and is to be checked when the item on the corresponding line in the bill of material has been completely disposed of. The next group of columns refers to finished parts, the first three referring to parts made in the shop, and the remainder of the group to parts purchased outside, excepting castings. The headings in the columns referring to manufactured parts made on stock orders give data of stock order, its number, and the number of pieces. The columns referring to purchased parts other than castings cover date of requisition on purchasing department, the requisition number, the purchase department number, its date, and date of receipt of material.

The next group of columns refers to castings. The left-hand group under this heading gives dates of requisitions for making patterns (the shop in question having its patterns made outside by a pattern job shop), the number of the pattern requisition, the purchase department order number, its date, and date pattern was delivered to foundry. If the pattern is already made a horizontal line is drawn through all columns excepting the one headed "Pattern delivered to foundry."

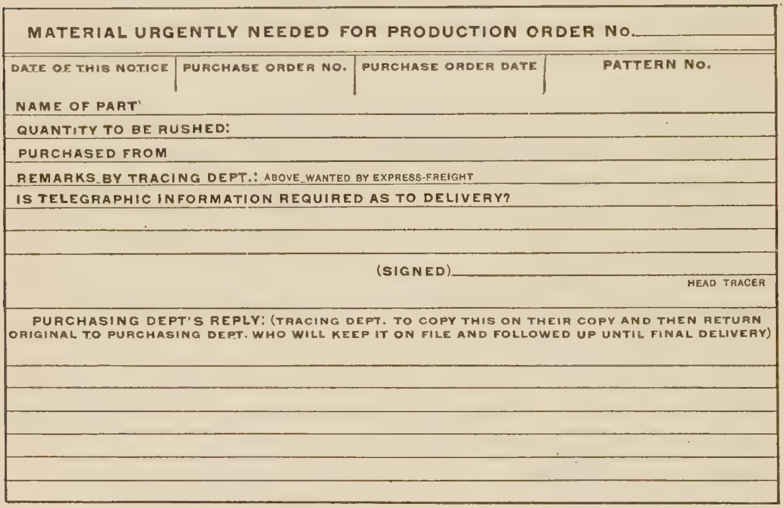
The next group of columns gives the date and number of the purchase order for castings, and the dates and amounts delivered from the foundries. The next columns headed, "Tags," refer to the tags accompanying material belonging to shop production orders in the shop. Entries are made in these columns from each day's tags, as they are written, indicating the date that the tags to go with the material have been written, also the date that the material is ready. In case material is not ready by reason of castings or other raw material not being in, the tags are kept in waiting boxes, either in the production or the receiving department, and proper date entries put into the column headed "Date material ready" as soon as the tags are ready to be lifted from the waiting boxes and sent to the shop by reason of the arrival of the needed material.

The last two columns refer to drawings and to manufactured parts. As soon as drawings are known to be ready, that column is dated, and as soon as parts manufactured on shop production orders are known to be finished a date is entered in the last column.

219. Hastening Purchased Items.—Fig. 93 shows a form used in urging the purchasing department to hasten material urgently needed. The form is self-explanatory. Carbon copies are filed in the production department, back of guide cards, designating order numbers.

Weekly meetings for the discussion of production problems are an absolutely essential accompaniment to systematic control of production. At such meetings there should be present not only shop foremen, but heads of all departments whose work deals with matters related to production, such as head of stores record department, head of purchasing department, and in some cases heads of sales department or some representative of the department. At these meetings summaries are presented detailing items on which promises of delivery have not been realized. Such lists may be advantageously made in manifold, a copy being given to each person concerned at some time previous to the holding of the meeting at which these questions are discussed.

A further refinement possible in some factories is the making of graphical curves, showing the hours work to be accomplished in a given department during the next four, eight, or more weeks plotted as one curve; also the number of available working hours in that department during the same period, based on the product of the number of employees multiplied by the number of hours per week that each man works.



MATERIAL URGENTLY NEEDED FOR PRODUCTION ORDER No.

DATE OF THIS NOTICE	PURCHASE ORDER NO.	PURCHASE ORDER DATE	PATTERN No.

NAME OF PART

QUANTITY TO BE RUSHED:

PURCHASED FROM

REMARKS BY TRACING DEPT.: ABOVE WANTED BY EXPRESS-FREIGHT

IS TELEGRAPHIC INFORMATION REQUIRED AS TO DELIVERY?

(SIGNED)

HEAD TRACER

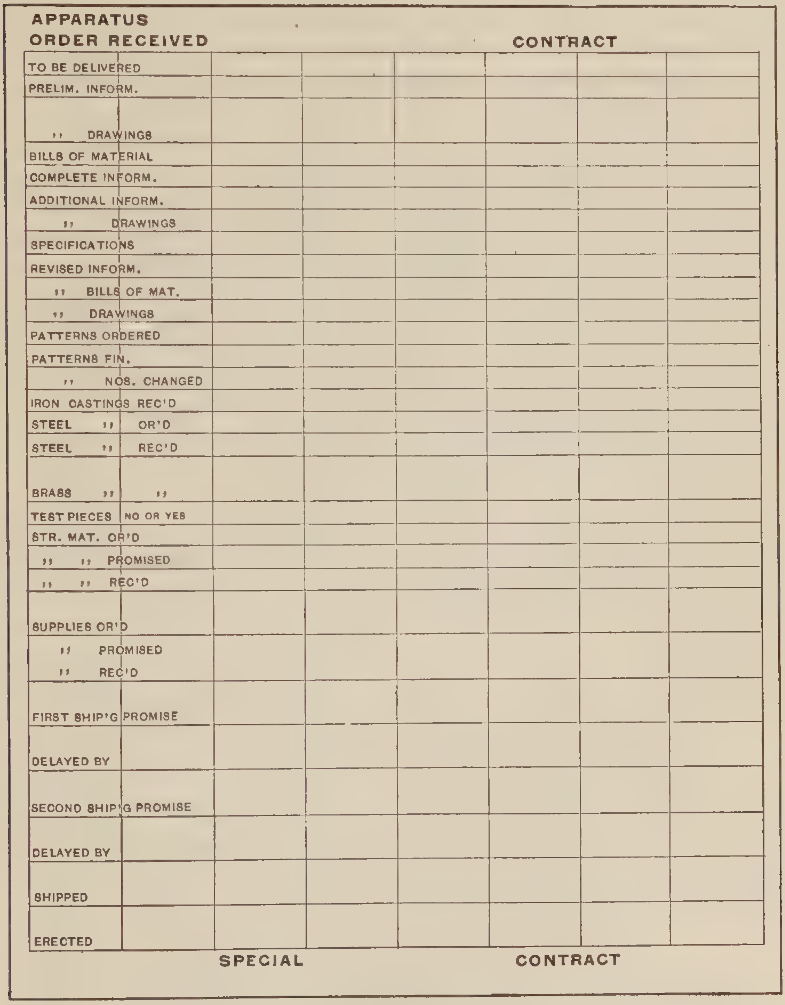
PURCHASING DEPT'S REPLY: (TRACING DEPT. TO COPY THIS ON THEIR COPY AND THEN RETURN ORIGINAL TO PURCHASING DEPT. WHO WILL KEEP IT ON FILE AND FOLLOWED UP UNTIL FINAL DELIVERY)

Fig. 93.—Form used by production department in urging purchasing department to hasten delivery of most badly needed items. Medium weight manila paper, 6 inches wide, 4 inches high.

220. Weekly Report for Foremen's Meeting.—A form for weekly report at foremen's meeting is shown in Fig. 94. Such report is useful only when it is made the basis of systematic and determined united action on the part of all concerned. The mere rendering of a weekly report to a superintendent or works manager soon becomes a perfunctory matter of but little value.

It will be readily seen that the production department as outlined requires for its head a man of firmness as well as amiability, and that each of his record clerks must be decidedly high-grade men from a standpoint of accuracy and knowledge of shop routine.

221. Shop Tags.—Reference has been made several times to the shop tag or tracing tag which accompanies a lot of goods through the shop. This tag is written as soon as the shop production order is written, and is issued to the shop only when the material is ready. A form for such tracing tag is shown in Fig. 95.



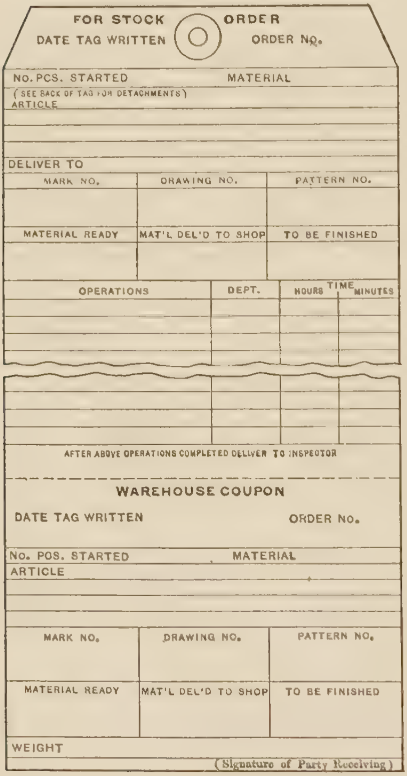
APPARATUS
ORDER RECEIVED CONTRACT

TO BE DELIVERED							
PRELIM. INFORM.							
" DRAWINGS							
BILLS OF MATERIAL							
COMPLETE INFORM.							
ADDITIONAL INFORM.							
" DRAWINGS							
SPECIFICATIONS							
REVISED INFORM.							
" BILLS OF MAT.							
" DRAWINGS							
PATTERNS ORDERED							
PATTERNS FIN.							
" NOS. CHANGED							
IRON CASTINGS REC'D							
STEEL "	OR'D						
STEEL "	REC'D						
BRASS "	"						
TEST PIECES	NO OR YES						
STR. MAT. OR'D							
" " PROMISED							
" " REC'D							
SUPPLIES OR'D							
" PROMISED " REC'D							
FIRST SHIP'G	PROMISE						
DELAYED BY							
SECOND SHIP'G PROMISE							
DELAYED BY							
SHIPPED							
ERECTED							

SPECIAL CONTRACT

Fig. 94.—Form for weekly report at foremen's meeting. White paper, 8 1/2 inches wide, 11 inches high.

The reverse of the tag is shown in Fig. 96. It is usually advisable to use different colored tags for different classes or series of orders; for instance, a buff-colored tag may be used for bill of material items, such as special castings, etc., which would not be made in stock-order lots. A yellow tag might be used for stock orders, a salmon tag for tool department orders, a manila tag for items to be charged to standing non-productive orders, a blue tag for plant addition orders, etc. The form shown contains spaces for insertion of the following: number of pieces started, the material, the name of the article, to what department it is to be delivered, the mark number, drawing number, pattern number, when material was ready, when it was delivered to shop, when it is to be finished, and a list of the operations to be done, such list being written in advance on the tag, together with department which is to do each operation, and the time allowed for each of the operations. Where detailed instruction cards are supplied, the tag need contain only the general routing, and reference to instruction card and tool lists by number.



FOR STOCK ORDER
DATE TAG WRITTEN ORDER No.
No. PCS. STARTED MATERIAL
(SEE BACK OF TAG FOR DETACHMENTS)
ARTICLE
DELIVER TO

MARK NO.	DRAWING NO.	PATTERN NO.
MATERIAL READY	MAT'L DEL'D TO SHOP	TO BE FINISHED

OPERATIONS	DEPT.	TIME HOURS	TIME MINUTES

AFTER ABOVE OPERATIONS COMPLETED DELIVER TO INSPECTOR

WAREHOUSE COUPON
DATE TAG WRITTEN ORDER No.
No. PCS. STARTED MATERIAL
ARTICLE

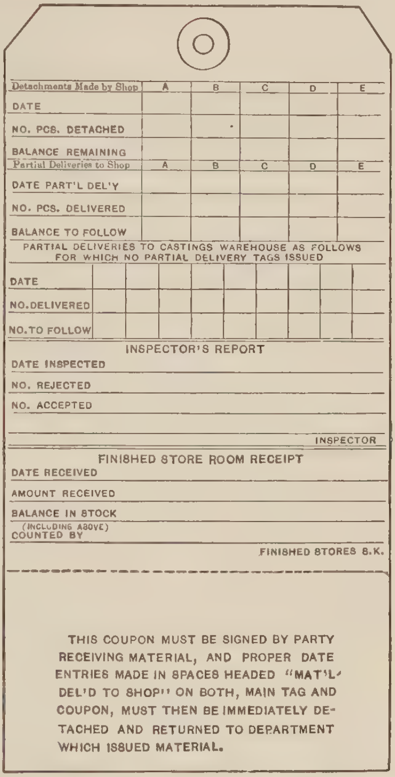
MARK NO.	DRAWING NO.	PATTERN NO.
MATERIAL READY	MAT'L DEL'D TO SHOP	TO BE FINISHED

WEIGHT
(Signature of Party Receiving)

FIG. 95.

At the bottom of the tag is the "Warehouse Coupon," or receipt, containing the same heading items as the main tag, and bearing on its reverse following instructions: "This coupon must be signed by party receiving material and proper date entries made in spaces headed 'Material delivered to shop,' on both main tag and coupon. Coupon must then be immediately detached and returned to department which issued material."

222. Detachments or Split Lots.—On the reverse of the tag there are provisions made for splitting the lot or making detachments in the shop. For such detachments exact copies are made of the original tag, excepting as to number of pieces, on a "Detachment or Partial Delivery Tag." This tag is just like the regular tag, excepting that instead of being printed in black type it is printed in red type, which immediately calls attention to the fact that the lot is a "Split lot" or "Detachment."



Detachments Made by Shop	A	B	C	D	E
DATE					
NO. PCS. DETACHED					
BALANCE REMAINING					
Partial Deliveries to Shop	A	B	C	D	E
DATE PART'L DEL'Y					
NO. PCS. DELIVERED					
BALANCE TO FOLLOW					

PARTIAL DELIVERIES TO CASTINGS WAREHOUSE AS FOLLOWS FOR WHICH NO PARTIAL DELIVERY TAGS ISSUED

DATE									
NO. DELIVERED									
NO. TO FOLLOW									

INSPECTOR'S REPORT

DATE INSPECTED

NO. REJECTED

NO. ACCEPTED

INSPECTOR

FINISHED STORE ROOM RECEIPT

DATE RECEIVED

AMOUNT RECEIVED

BALANCE IN STOCK (INCLUDING ABOVE)

COUNTED BY

FINISHED STORES S.K.

THIS COUPON MUST BE SIGNED BY PARTY RECEIVING MATERIAL, AND PROPER DATE ENTRIES MADE IN SPACES HEADED "MAT'L DEL'D TO SHOP" ON BOTH, MAIN TAG AND COUPON, MUST THEN BE IMMEDIATELY DETACHED AND RETURNED TO DEPARTMENT WHICH ISSUED MATERIAL.

FIG. 96.—Reverse of form shown in Fig. 60, showing "splits" or "detachments," also inspector's and storeroom reports.

The tag shown provides for the possibility of five distinct detachments being made by the shop, owing to the rushing of individual lots on a stock order, giving the date of the detachment, the number of pieces detached and advanced, and the balance remaining with the original tag.

Next follows a record of partial deliveries to the shop in case only part of the castings or other raw material have arrived, and it is decided to send this partial supply out into the shop. In this case the receiving department furnishes the production department the information of receipt of only part of the material, and the production, department decides whether or not to have the partial delivery tags written, and retain the main tag in the receiving department office until the last lot is received by them and delivered to the shop.

In case the receiving department is accumulating raw material by sending it to stores until the full supply is in, which would be the normal condition, it being preferred to send out the regular manufacturing quantity, the next set of spaces is used, which is headed, "Partial deliveries to castings warehouse as follows, for which no partial delivery tags issued." This set of memoranda keep the receiving department posted as to the number of castings they have received and must expect before they may let the tag go out.

Next follows a space for inspector's report which is filled in after all the operations have been done, and the pieces come to the inspection department for approval before being turned into stores.

Then follows an indorsement by the storeroom, giving date and amount received with the tag, also the balance in stock, including this lot and by whom counted, furnishing a balance by actual count. The tag is sent from the storeroom to the stores record clerk, who posts it in his stores record of manufactured finished parts.

223. Transfer Clerk.—In several successful manufacturing establishments, the head tracer of the production department has his headquarters in the very center of the shop. He has charge of all of the "stock-movers," or truckers, who haul work in process from one department to another, and whenever such interdepartmental transfer takes place the stock-mover passes with his truck and its load of work in process and the accompanying shop tags past this head tracer's or "transfer clerk's" post, stopping there so that the transfer clerk may get the record. In this way the head tracer or transfer clerk actually sees the pieces themselves as they go from department to department, and can shift cards in index boxes or in grooves, or hang tags or checks on hooks in a manner indicating the travel of each lot of pieces of work in process, from department to department, so that he has positive and instant information as to the exact location of each lot. From these card indexes or grooved trays or check-boards, the tracing department can then accumulate for collective groups or complete machines the record of progress, posting same on a bill of material or other record form.

224. Estimate of Times of Completion.—After a tracing system is in thorough working order, and it is possible to tell the exact location of any piece or group of pieces, it is but a step further to inaugurate a system of estimated times of completion of each lot in each department. One of the large electric manufacturing companies has brought this system of promised dates of completion to a state of high efficiency, by keeping a monthly record of each foreman's percentage of correctness in estimating the time of completion. Prizes and promotions are accorded for the highest percentages, and whereas at the beginning of the system the highest percentage was below 60, after six months' operation a number of foremen were able to bring their percentages over 90, a state of affairs which seems almost incredible to the ordinary factory superintendent.

REFERENCES

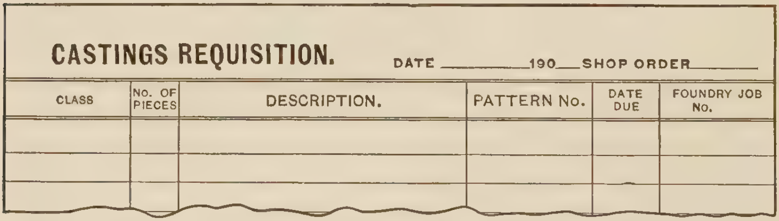
Taylor: "Shop Management," Pars. 258–311.
Gilbreth: "Primer of Scientific Management," Chapter III.
Parkhurst: "Applied Methods of Scientific Management," Chapter III.

CHAPTER XVIII

FOUNDRY SYSTEMS

225. Castings Requisitions.—Inasmuch as the foundry is in many establishments an integral part of the factory, the following outline of foundry systems is given, more with a view of the foundry as a shop department than of the foundry as a job shop.

The requisition for castings emanates from a stores record clerk who initiates such requisition for one of the following reasons: 1. As he enters reservations for production orders or shipping orders, he finds that his balance on hand, deducting reserve, falls below the minimum stock as specified on his stock sheet. He thereupon writes out a castings requisition. Where the establishment has no foundry of its own, this castings requisition goes to the purchasing department. Where the foundry is a shop department, this requisition is sent to the foundry foreman.



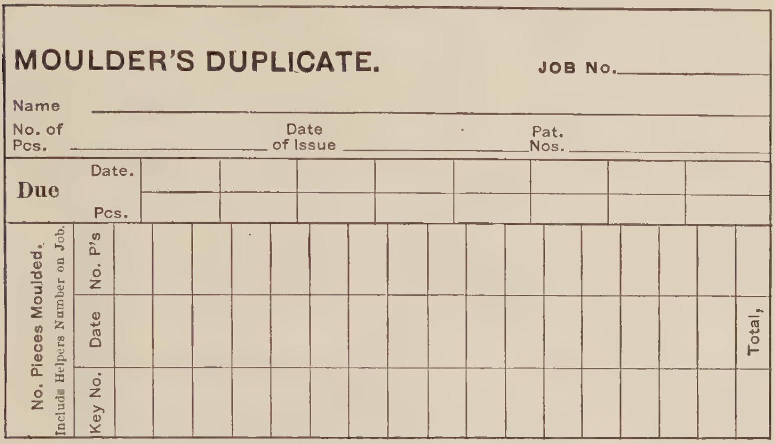
CASTINGS REQUISITION. DATE ________190___SHOP ORDER________

CLASS	NO. OF PIECES	DESCRIPTION.	PATTERN No.	DATE DUE	FOUNDRY JOB No.

FIG. 97.—Requisition to make castings. White bond paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.

Fig. 97 shows a form for such castings requisition. This requisition bears columns headed as follows: "Class," "Number of Pieces," "Description," "Pattern Number," "Date Due," "Foundry Job Number." The foundry foreman's clerk assigns the foundry job numbers consecutively as they are received, beginning with number one as the first order of the year. One copy of the castings requisition is sent to the pattern shop, and two to the foundry. One of these foundry copies is returned to the stores record clerk with the foundry job numbers inserted.

226. Moulders' and Coremakers' Order Copies.—On receipt of the castings requisition the foundry clerk makes out two similar job cards, viz., Fig. 98, "Moulder's Duplicate." and Fig. 99, "Coremaker's Duplicate." Both of these cards are attached



MOULDER'S DUPLICATE. JOB No.________

Name ________

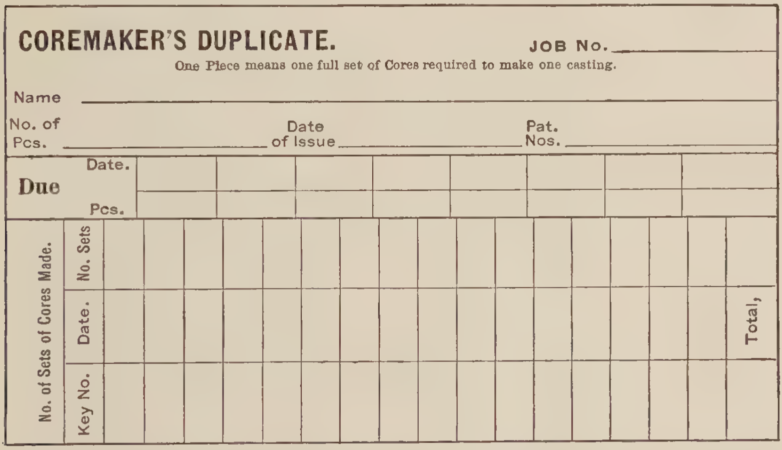
No. of Pcs. ________ Date of Issue ________ Pat. Nos. ________

Due	Date.								
	Pcs.								

No. Pieces Moulded. Include Helpers Number on Job.	No. P's																	
	Date																	Total,
	Key No.																	

FIG. 98.—Moulder's card, copy of order to make castings with tracing record on same. Manila card, 5 inches wide, 3 inches high.

to the pattern shop's copy of the castings requisition, and are sent to the foreman of the pattern shop. The foreman of the pattern shop hands them to the pattern carrier with instructions



COREMAKER'S DUPLICATE. JOB No.________

One Piece means one full set of Cores required to make one casting.

Name ________

No. of Pcs. ________ Date of Issue ________ Pat. Nos. ________

Due	Date.								
	Pcs.								

No. of Sets of Cores Made.	No. Sets																	
	Date.																	Total,
	Key No.																	

FIG. 99.—Coremaker's card, copy of order to make castings, with tracing record covering cores made. Manila card, 5 inches wide, 3 inches high.

to get the patterns that these cards call for. He tacks the Moulder's Duplicate to the pattern itself, and sends the pattern

FOUNDRY'S DAILY RECORD OF WORK DONE

Date________

Page________

Note—Send this Copy to General Office.

Help		Shop Order No.		Foundry Job No.		No. of Pieces	Hours	Weight in Pounds	DESCRIPTION	Pattern No.
Key No.	Hours									

Fig. 100.—Foundry clerk's daily record of work done. White bond paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.

to the foundry. In case the pattern has to be made, the moulder's duplicate card is kept on file in the pattern shop, remaining attached to the pattern shop's copy of castings requisition until the pattern is made.

The core-maker's duplicate is handed to the foreman of the core-room.

227. Daily Record of Work Done.—As the foundry work is completed the foundry time-keeper collects the card orders and turns them back to the foundry clerk. The foundry clerk makes up, for his own guidance from these returning cards, a daily record of work done (Fig. 100), such record bearing columns with the following headings: "Help" (this column containing check number and time of moulder and helpers), "Shop Order No.," "Foundry Job No.," "Number of Pieces," "Time," "Weight" (scrap, if any, being specified), "Pattern Number," "Description." The foundry

FOUNDRY DELIVERY RECORD.

Date______

Page______

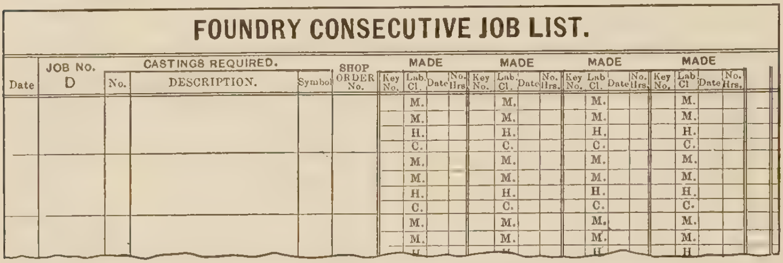
Note—Send this Copy to General Office.

	Shop Order No.	S.O. ck.	Foundry Job No.	Job ck.	No. of Pieces	Pcs. ck.	Weight in Pounds	DESCRIPTION	Pattern No.
REMEMBER. *If the Duplicate should be divided place the date in-this-margin-for-each later delivery, so that it will show on the remaining duplicate sections.*									

Fig. 101.—Foundry clerk's daily record of castings delivered. White bond paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.

clerk takes this record sheet into the castings cleaning-room and uses it as a help in finding the castings.

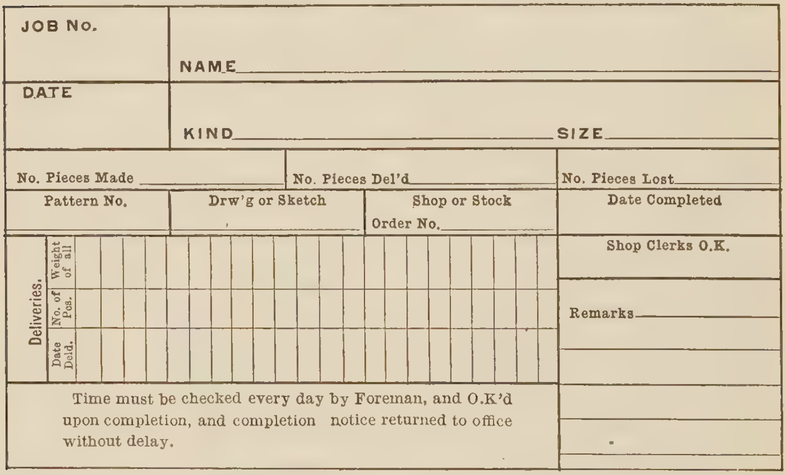
228. Daily Delivery Record.—He then makes out a delivery record similar to Fig. 101 making it in triplicate, one copy going to the production department, one copy going to the machine shop, and one copy being retained in the foundry. The general headings on this foundry delivery record are "Date" and "Page."



FOUNDRY CONSECUTIVE JOB LIST.

	JOB NO.	CASTINGS REQUIRED.			SHOP	MADE				MADE				MADE				MADE			
Date	D	No.	DESCRIPTION.	Symbol	ORDER No.	Key No.	Lab. Cl.	Date	No. Hrs.	Key No.	Lab. Cl.	Date	No. Hrs.	Key No.	Lab. Cl.	Date	No. Hrs.	Key No.	Lab Cl	Date	No. Hrs.
							M.				M.				M.				M.		
							M.				M.				M.				M.		
							H.				H.				H.				H.		
							C.				C.				C.				C.		
							M.				M.				M.				M.		
							M.				M.				M.				M.		
							H.				H.				H.				H.		
							C.				C.				C.				C.		
							M.				M.				M.				M.		
							M.				M.				M.				M.		

Fig. 102.—Foundry clerk's consecutive job list. White bond paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.



JOB No.

NAME

DATE

KIND

SIZE

No. Pieces Made

No. Pieces Del'd

No. Pieces Lost

Pattern No.

Drw'g or Sketch

Shop or Stock Order No.

Date Completed

Deliveries.

Weight of all

No. of Pcs.

Date Deld.

Shop Clerks O.K.

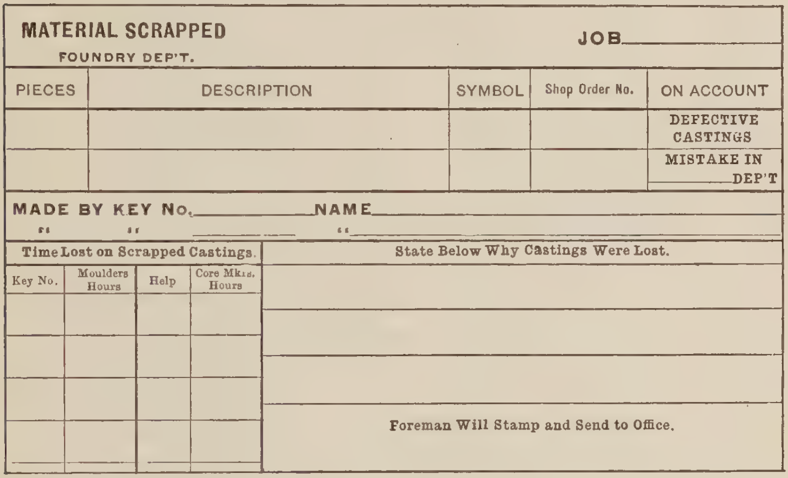
Remarks

Time must be checked every day by Foreman, and O.K'd upon completion, and completion notice returned to office without delay.

Fig. 103.—Foundry clerk's tracing card. Gray card, 5 inches wide, 3 inches high.

The vertical columns are headed "Shop Order Number," and a column for checking, "Foundry Job Number," and a column for checking, "Number of Pieces," and a column for checking, "Weight," "Description" and "Pattern Number." There is also a blank column at the extreme left which is used for entering a reference to subsequent deliveries on the same order number. After filling out the foundry delivery sheet, the foundry clerk returns again to the castings requisition sheet, and posts in the column headed "Description" the date of completion and number of pieces completed. As soon as any one castings requisition sheet is filled out showing that all items have been delivered, this sheet is retired to a file of completed castings requisitions.

229. Consecutive Job List.—The foundry clerk also writes out daily a Finding List or index sheet, using for that purpose a sheet entitled "Foundry Consecutive Job List," shown in Fig. 102.



MATERIAL SCRAPPED JOB__________

FOUNDRY DEP'T.

PIECES	DESCRIPTION	SYMBOL	Shop Order No.	ON ACCOUNT
				DEFECTIVE CASTINGS
				MISTAKE IN ________ DEP'T

MADE BY KEY No.__________ NAME__________

" " __________ " __________

Time Lost on Scrapped Castings.

Key No.	Moulders Hours	Help	Core Mkrs. Hours

State Below Why Castings Were Lost.

Foreman Will Stamp and Send to Office.

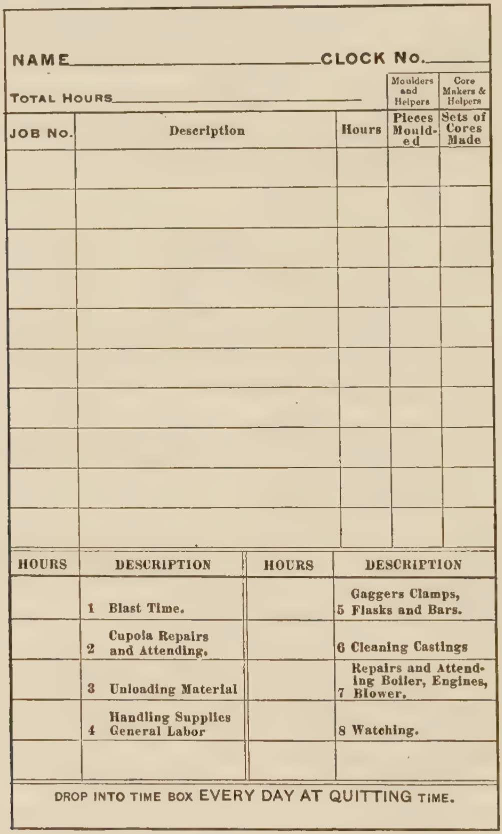
FIG. 104.—Record of defective castings, filed back of cards shown in Fig. 68, a duplicate going to superintendent and another copy to production department. Yellow bond paper, 5 inches wide, 3 inches high.

The columns in this list bear headings as follows: "Date," "Job Number," "Number of Pieces." "Description," "Shop Order Number," "Class of Labor" and "Time."

230. Foundry Tracing Card.—The foundry clerk prepares also each day a number of cards (Fig. 103) for the purpose of answering any questions as to the date of delivery of castings, number of castings scrapped, and state of completion of any job. These cards are filed back of guide cards showing job number, and are written up at the same time as the writing up of the cards entitled, "Core-makers' Duplicate," and "Moulders' Duplicate."

Entries are posted on these cards from the "Foundry Delivery Record" (Fig. 101).

231. Scrapped Material.—To the back of each of these cards are attached by "clips" notices of defective castings, where such have occurred; these notices (headed "Material Scrapped") are made out on a form similar to Fig. 104, a copy of this form being sent to the production department. On receipt of scrap notices a new order is entered on a foundry requisition to cover the loss.



NAME ________________ CLOCK NO. ______

TOTAL HOURS ________________

			Moulders and Helpers	Core Makers & Helpers
JOB NO.	Description	Hours	Pieces Moulded	Sets of Cores Made

HOURS	DESCRIPTION	HOURS	DESCRIPTION
	1 Blast Time.		5 Gaggers Clamps, Flasks and Bars.
	2 Cupola Repairs and Attending.		6 Cleaning Castings
	3 Unloading Material		7 Repairs and Attending Boiler, Engines, Blower.
	4 Handling Supplies General Labor		8 Watching.

DROP INTO TIME BOX EVERY DAY AT QUITTING TIME.

FIG. 105.—Foundry workman's time card. Manila card, 3 1/2 inches wide, 6 inches high.

232. Clerical Help Required.—In a foundry employing thirty or forty moulders, six to ten core-makers, eight to ten men in the cleaning-room, and six to eight men in the yard, a foundry clerk

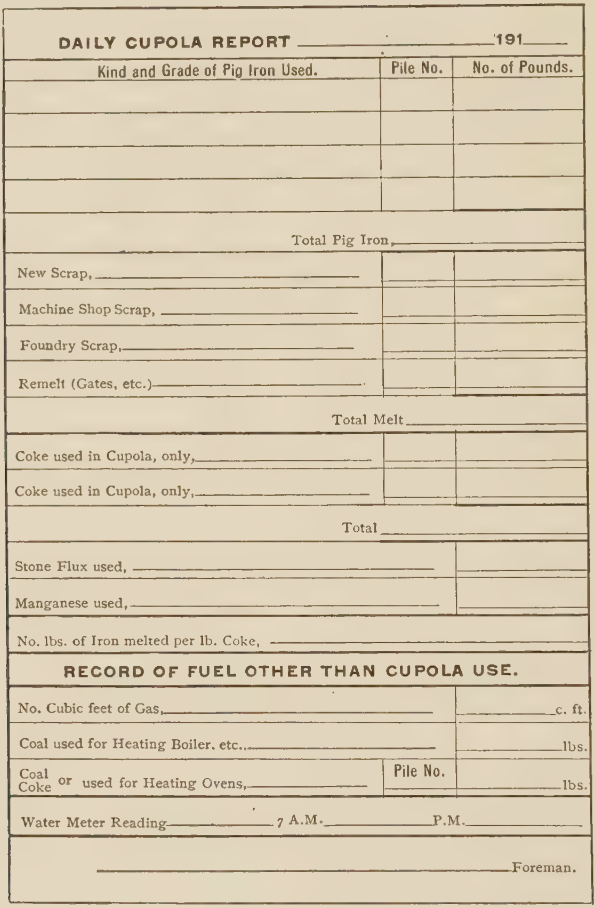
FOUNDRY CUPOLA CHARGE SHEET FOR____________________191______

CAR No.	MAT'L	2	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	TOTAL
	COKE																				
	Pig																				
	Pig																				
	Pig																				
	Scrap																				
	No.1 S.																				
	Remelt																				
	O.F.R.																				
	Flux																				

CAR No.	MAT'L	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	TOTAL
	COKE																				
	Pig																				
	Pig																				
	Pig																				
	Scrap																				
	No.1 S.																				
	Remelt																				
	O.F.R.																				
	Flux																				

FIG. 106.—Cupola charge record. White linen paper, 14 inches wide, 8 1/2 inches high.

assisted by one time-taker can keep records of sufficient accuracy for all ordinary cost-finding purposes, provided, of course, that the time-taker has no other duties than those connected with the time-taking.



DAILY CUPOLA REPORT ________ 191___

Kind and Grade of Pig Iron Used.	Pile No.	No. of Pounds.
Total Pig Iron, ________		
New Scrap, ________		
Machine Shop Scrap, ________		
Foundry Scrap, ________		
Remelt (Gates, etc.) ________		
Total Melt ________		
Coke used in Cupola, only, ________		
Coke used in Cupola, only, ________		
Total ________		
Stone Flux used, ________		
Manganese used, ________		
No. lbs. of Iron melted per lb. Coke, ________		
RECORD OF FUEL OTHER THAN CUPOLA USE.		
No. Cubic feet of Gas, ________		________ c. ft.
Coal used for Heating Boiler, etc., ________		________ lbs.
Coal or Coke used for Heating Ovens, ________	Pile No.	________ lbs.
Water Meter Reading ________ 7 A.M. ________ P.M. ________		
________ Foreman.		

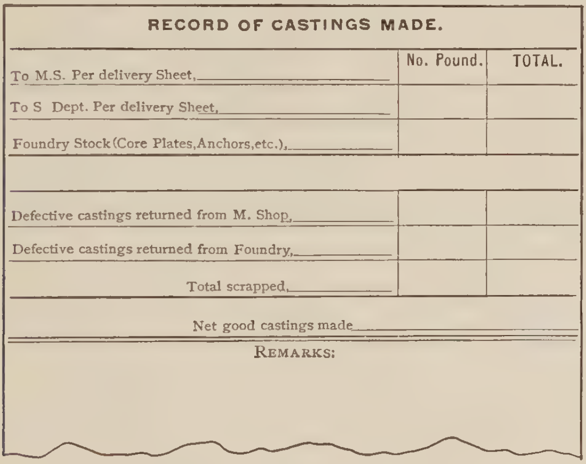
FIG. 107.—Daily cupola report. Manila card, 5 1/2 inches wide, 8 1/2 inches high.

233. Indirect Foundry Labor.—The time of men working in the cleaning-room is usually charged wholly to a standing order covering "Cleaning Castings." The yard work, such as unloading and handling pig iron, coke, etc., may sometimes be put with considerable advantage on a piece work or premium basis.

Time of moulders spent in pouring is charged to a standing order under the head of "Blast Time."

234. Foundry Time Ticket.—A form for Foundry Workman's Time Ticket is shown in Fig. 105.

235. Daily Cupola Reports.—In the matter of cupola reports, it is desirable that these be filled out by a careful and responsible person who remains on the charging platform during the blast and, while there, enters the weight of each charge as it is made, recording the amount of iron and the number of the car from which it was taken. This serves as a check on the weight of the cars, and secures greater accuracy as to the kind of iron. The entries made on the "Daily Record of Work Done" and the charge sheet, a form for which is shown in Fig. 106, are summarized into a daily cupola report; shown in Fig. 107 and a "Record of Castings Made," shown in Fig. 108 which are simply a condensation of the separate items entered on the previous forms.



RECORD OF CASTINGS MADE.

	No. Pound.	TOTAL.
To M.S. Per delivery Sheet,		
To S Dept. Per delivery Sheet,		
Foundry Stock (Core Plates, Anchors, etc.),		
Defective castings returned from M. Shop,		
Defective castings returned from Foundry,		
Total scrapped,		

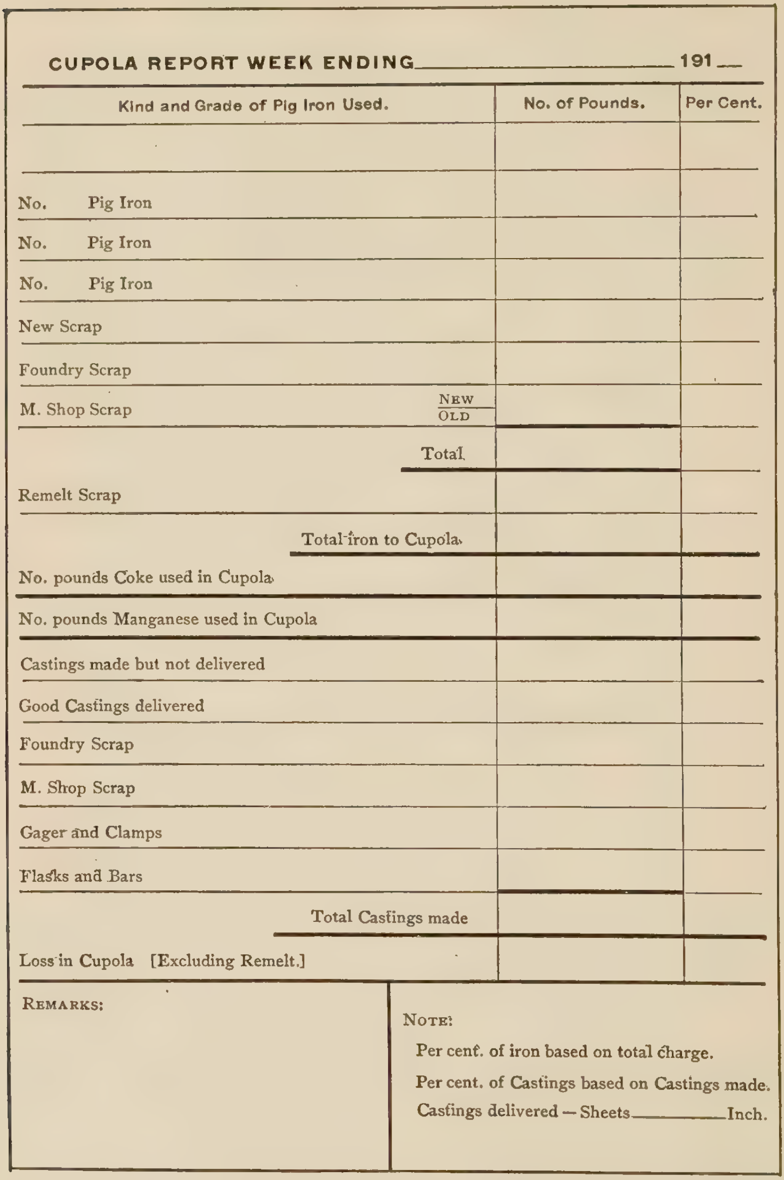
Net good castings made

REMARKS:

FIG. 108.—Reverse of Fig. 79.

In cases where there is a possibility of the weight of castings fluctuating from a desired standard to which it is intended that the foundry shall adhere strictly, it is desirable that the standard weight be entered on orders and job tickets so that these weights are noted by the foundry employees.

236. Weekly Cupola Reports.—A summary is made of the daily cupola reports once a week, such weekly summary being made in triplicate, one copy remaining on file in the foundry,



CUPOLA REPORT WEEK ENDING__________________191__

Kind and Grade of Pig Iron Used.	No. of Pounds.	Per Cent.
No. Pig Iron		
No. Pig Iron		
No. Pig Iron		
New Scrap		
Foundry Scrap		
M. Shop Scrap NEW OLD		
Total		
Remelt Scrap		
Total iron to Cupola		
No. pounds Coke used in Cupola		
No. pounds Manganese used in Cupola		
Castings made but not delivered		
Good Castings delivered		
Foundry Scrap		
M. Shop Scrap		
Gager and Clamps		
Flasks and Bars		
Total Castings made		
Loss in Cupola [Excluding Remelt.]		

REMARKS:

NOTE:

Per cent. of iron based on total charge.

Per cent. of Castings based on Castings made.

Castings delivered — Sheets__________Inch.

FIG. 109.—Weekly cupola report. White bond paper, 5 1/2 inches wide, 8 1/2 inches high.

one being sent to the shop superintendent, and one to the works manager. Fig. 109 shows a form for such weekly cupola report.

REFERENCES

KNOEPPEL: "Maximum Production." Chapters IV to XIV.

PERRIGO: "Modern Machine-shop Construction, Equipment and Management," Chapter XXI.

CHAPTER XIX

THE MACHINE SHOP AND TOOL DEPARTMENT

237. Arrangement of Machines.—The arrangement of the various machines in the machine shop will depend somewhat upon the general tendency of the sequence of operations. Such a general tendency cannot be established from a few parts of the product, but can be ascertained only by a careful study of the processing and most advantageous routing of all of the component items involved in the output.

In addition to leaving room enough for working and storing a considerable supply of work in process, room should be left for the installing of additional machines with each group of the same kind of machines.

238. Foremen and Gang Bosses.—Most machine shops are insufficiently officered. The foreman of the machine shop is compelled in many well-equipped and otherwise well-organized shops to do all of the following up of orders in his department, to act as an expert in processing, to design new tools, and to hire labor. Under such conditions anything like reasonably high efficiency is unthinkable. The general foreman of the machine shop should be assisted by an assistant foreman, who has charge of the strictly machine work processes, another assistant foreman to act in charge of the strictly bench and vise work and group-assembling part of the machine shop, and still another assistant foreman in charge of erecting work. In addition to these assistant foremen, there should be a sub-foreman or gang boss for each group of machine tools, and for each specialty in assembling and erection work. These gang bosses, who are the expert mechanics in each group, spend most of their time in direct productive work themselves, and about one-fourth or one-fifth of their time in indirect work in instructing and helping others in their group.

239. Tool Room Independent of Machine Shop.—The tool-room should be either a department independent of the machine shop, or, if under the supervision of the general foreman of the machine shop, there should be a separate foreman of the tool department. The foreman of the tool department in turn should be relieved of all duties pertaining to storage of tools and blue-prints. This work should be in the hands of a competent assistant in the tool department so that the foreman of the tool-room may devote practically his entire energies to questions having to do with the making and purchase of tools.

240. Relieving Foremen of Clerical Work.—If the general machine-shop foreman is provided with a competent staff of assistants, as above outlined, he will be able to confer intelligently with the head of the production department and tracers, and may be expected to make reasonably accurate statements as to time of completion of work in process. He can never have his orders well in mind or well in hand, however, if he is overworked, as most machine-shop foremen are, with a multitude of various responsibilities beyond the mental capacity of one man.

The issuing of shop orders and following them up are duties which in the best shop organization are delegated to the production department, a department entirely independent of the machine shop. Similarly, workingmen's time records belong to the time-keeping department. Records of employees are kept in the employment department. The fact that these last-named records are kept in a separate department does not in any way lessen the authority of the department foremen in approving or disapproving of the men in their charge or sent them for final decision as to employment.

The data for filling in efficiency records must, of course, be obtained from the department foreman. The keeping of records is work of a nature, however, that is so different from the regular routine of a department foreman that the necessary records will almost certainly fail to be kept up unless the labor of recording is centered under separate supervision. When all of the above duties have been removed from the machine shop, the general foreman will have opportunity to look around the shop.

While it is sometimes impracticable to have the desk of the general foreman so located that he can have a clear view of all of the shop territory under his control, it is almost always possible, and certainly desirable, to locate sub-foremen in such a way that they can at all times have a full view of all of the men working under them.

241. Moving Work in Process.—It will usually be found advisable to have one or more laborers assigned to the work of stock-moving. It is the stock-mover's business to see that a piece of work, finished in any one department, is quickly taken to the place where the next operation is to be performed, and to its proper destination as soon as the last operation has been performed. It is the stock-mover's duty to assist the inspection department in seeing that all articles requiring inspection are promptly brought to the attention of the proper person delegated to do such inspection after each set of operations involving inspection.

242. Call Bells.—It has been found useful in many shops where the yard gang or casting cleanings force constituted the main supply of laborers, to have an annunciator located at those places in charge of some one man, this annunciator being connected to push buttons located at various parts of the shop where they are pressed when a laborer is wanted.

A similar call-bell system is used in many shops for calling boys from the tool-room to get tools, drawings, requisitions, etc., the men pressing their push buttons some little time before the article is needed, and in that way avoiding any loss of time. One push button will answer for a considerable floor area. When the boy arrives at the area corresponding to the number of his call, he simply calls out, "tool-room boy," so as to attract the attention of the man who wanted him. A better plan is to have the tool room prepare boxes or portable stands supplied with tools as per tool lists for each day's jobs in accordance with the bulletin board showing order of work such tools being furnished to each man prior to his beginning his next job.

It must be borne in mind that the mere running of machine tools at their best feeds and speeds is not in itself any guarantee of most efficient production, since delays between operations constitute the greatest loss of time. It is these delays which are cut out by the use of well-managed premium or gain-sharing wage systems, good methods of routing, scheduling, and stock moving, and orderly arrangements.

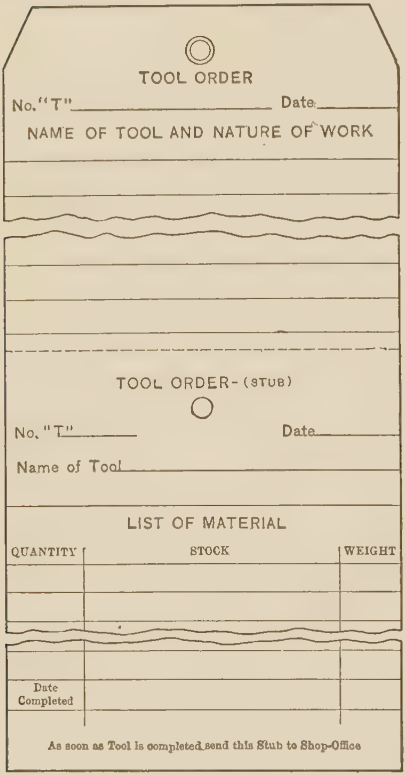
243. Issuing Blue-prints.—The head of the tool storage and blue-prints issuing room should be constantly following all blue-prints and tools so that, unless they are in current use, they are promptly returned to storage. Blue-prints drawn by foremen should not be given out by them to the men. There should be an office set of blue-prints bound together in sets, each set representing all of the drawings required for a certain product. These sets should be kept for reference in the machine-shop office only, and not be taken away from that office. Blue-prints for use by workingmen should be kept in the tool storage room and drawn on checks or issued with tool lists the same as shop tools. This practice results in the prints which are in the shop office always representing complete sets. The systematic arrangement of the record sets is thus not interfered with.

It is desirable to enclose separately by a grating, and keep under lock and key such part of the tool-room as is wholly devoted to storage and issuing on checks of tools and blue-prints. This separate grating is in addition to the general grating or partition which encloses the machinery engaged in tool-making work.

244. Repairs to Machinery and Transmission Apparatus.—In most small or medium-size shops, it will be found convenient to have the repair and maintenance work of the machine shop on transmission equipment and machinery as one of the duties of the foreman of the tool-room. He in turn may have one employee in his department whose specialty is such repairing and maintenance work, and he may have to call a considerable number of machinists and laborers to his assistance at times. At such times he should, of course, confer with the foreman of the machine tool department and the man who has general charge of the laborers. In a small establishment a single standing order will suffice, to which all labor and material for repairs and maintenance of shafting, belting, etc., may be charged. In larger factories it will be found desirable to have separate standing orders covering the repairs and maintenance of transmission apparatus in each department, so that this expense may be properly localized in determining the operating expense of each department.

Orders covering repairs or alterations to machinery are best taken care of by letting each order bear the number which is on the number-plate fastened to each machine, and which number appears on the card inventory of machinery. The orders of this series should emanate from the tool-room, where a brief description of the nature of the repair or alteration is stated in the wording of the order, so that this brief statement may be transcribed on to the inventory card, after the cost department has turned in a record of the cost of time and material. The actual doing of repair work on machines need not wait for the formal typewriting of the order by the order department, since such repair work on machines is usually an urgent matter. The only object in having the order department typewrite the order is for the purpose of having the record of the nature of the repair.

245. Orders for Making Tools.—In the chapter on the Order Department, it has already been stated that it is advisable to have a separate series of orders for the tool-room. The foreman of the tool-room should be provided with a form on which he may write a request for the issuance of an order. Prompt attention must be given to these requests by the head of the planning department, who should give instructions to the operator of the billing machine on which shop orders and accompanying shop tags are written, that such tool-room orders and tags be promptly typewritten and delivered to the messenger without delay. In a small establishment, the tool-room foreman may himself write out the tags which accompany tool-room jobs, instead of having a separate order form. Fig. 110 shows a form for such tool-rcom order tag. He may keep a book in which he writes a description of the consecutive orders. He should have the general foreman or superintendent enter his initials opposite each of the items in this book, designating that it has been duly authorized. It is also very advisable to have a column in this book in which is entered the tool-room foreman's estimate of cost as he makes it at the time of asking the approval of the general foreman or superintendent, and an adjacent column



TOOL ORDER

No. "T" ____ Date ____

NAME OF TOOL AND NATURE OF WORK

TOOL ORDER-(STUB)

No. "T" ____ Date ____

Name of Tool ____

LIST OF MATERIAL

QUANTITY	STOCK	WEIGHT
Date Completed		

As soon as Tool is completed send this Stub to Shop-Office

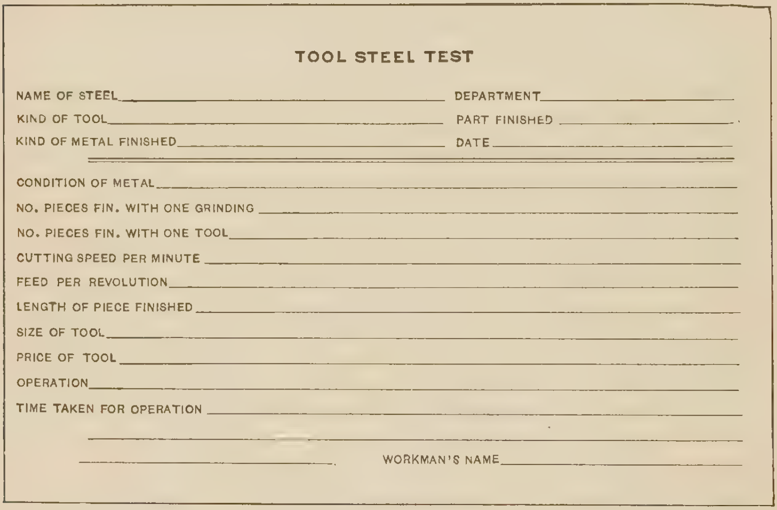
FIG. 110.—Form for tool order tag. Stub kept in tool department till order is completed. Salmon tag stock, reinforced eyelets, 4 1/8 inches wide, upper portion 5 inches high, lower portion (stub) 6 inches high.

in which is posted the cost department's report of the actual cost of the tool or fixture after it has been finished. These columns will serve as a very good basis for improving the efficiency of the head of the tool-room as an estimator of probable costs of tooling equipment. Where the tool-room foreman writes out the tag which accompanies the tool or fixture in process of manufacture, it is advisable that he keep a stub of this tag on file, on which he enters material issued with the order or subsequently drawn for it. If it is drawn from his own stock, shop tags accompanying tool-room work will, of course, be of a separate color from tags on other order series, and when a tool-room job is sent into the regular machine shop, the shop tag should of itself be sufficient authorization for the doing of the work. The tag accompanying such work should bear the signature or rubber stamp authorization of the general machine-shop foreman, showing that he has approved the order for work outside of the tool-room to be done on it.

246. Record of Small Tools.—The record of files, small tools, etc., that are drawn from a tool-room ought to be localized to individual workmen and summarized for monthly comparison. The reason should be written on each requisition on the tool storage room for the issuing of new tools or tool replacement. A proper system of standing non-productive orders will provide data for comparison of these accounts from month to month with a view to encouraging economy.

247. Repetition Work by Tool-makers.—In a tool-room of considerable size there is apt to be a good deal of duplicate work, such as the making of hardened bushings for the holes in drilling jigs, etc., which can be put on a premium, bonus, or gain-sharing wage basis. The same is true of similar jobs occurring often, and so nearly alike that they are practically the same. The head of the tool-room should compile the cost data of recurring jobs in just the same manner that the works manager is considering the manufactured product.

248. Tool Steel Tests.—The head of the tool department should compile the results of tests of tool steel with a view to determining what kinds of tool steel are best for the various kinds of work in the shop. If there are men in the shop employed to do time-study work for the purpose of establishing premium, bonus, or piece rates, such men's observations may be made to coöperate in securing the necessary data wanted in connection with tool steel tests. Fig. 111 is a form used for recording the data of an individual test of tool steel. Fig. 112 is a form used for summarizing the results of a number of individual tests. Some authorities argue that it is totally incorret to base any conclusions on the amount of work that can be done with one tool without regrinding. Mr. F. W. Taylor bases his speeds and feeds on the maximum to be gotten out of a tool in an hour and a half without regrinding. If replacement of cutters requires a long, slow-grinding process, and occasional reforging, then a relatively slower speed must be chosen than where facilities are at hand for quick replacement and regrinding of cutters.



TOOL STEEL TEST

NAME OF STEEL ______ DEPARTMENT ______
KIND OF TOOL ______ PART FINISHED ______
KIND OF METAL FINISHED ______ DATE ______

CONDITION OF METAL ______
NO. PIECES FIN. WITH ONE GRINDING ______
NO. PIECES FIN. WITH ONE TOOL ______
CUTTING SPEED PER MINUTE ______
FEED PER REVOLUTION ______
LENGTH OF PIECE FINISHED ______
SIZE OF TOOL ______
PRICE OF TOOL ______
OPERATION ______
TIME TAKEN FOR OPERATION ______

______ WORKMAN'S NAME ______

Fig. 111.—Form for recording tool steel test. White bond paper, 8 1/2 inches wide, 5 1/2 inches high.

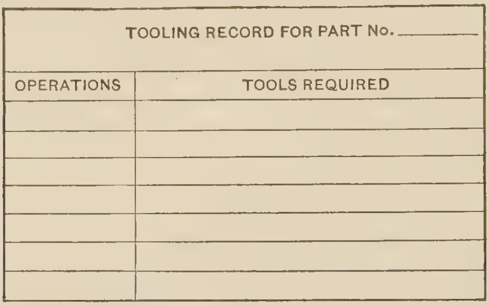
249. Scheduling Machine-shop Work.—The Production or Planning Department must have planned long before a man is through with a job what that man is to do next, so that there is no such thing as a workman standing around and waiting for a job or being given something merely to keep him from being idle, and then being compelled to change his job as soon as the foreman finds something that is more urgent. The practice is becoming more and more general of having a sub-foreman in charge of only a limited number of men or machines, and giving him a board on which there is a hook or peg to represent each machine or working man in his department. On this peg he must have hanging, every evening, a sufficient number of duplicate shop order tags to provide the working man whom the peg or hook represents, with a full day's work on the following day. To be sure, when the next day comes the order of work may have to be slightly modified, but where this system is put into practice it will be found that there will be less need of dropping a job and changing to another than without such systematic planning.

No. of test				
No. of part finished				
Workman's number				
Department number				
Operation				
Time taken for operation				
Kind of metal finished				
Condition of metal				
Size of piece finished				
Name of tool steel used				
No. of pieces fin. with one grinding				
Speed in feet per minute				
Feed in inches per revolution				
Price of steel per lbs.				
Cost of Steel used per 100 pieces				
Price of operation per 100 pieces				
Wages this man averages per day				
Years production				
Saving per 100 pieces				
Net saving per 1 yrs. production				

Fig. 112.—Form for summarizing tool steel tests. White bond paper, 8 1/2 inches wide, 11 inches high.

250. Tool Lists for Manufactured Parts.—The head of the tool-room should have a card index arranged by names, and mark numbers of product. On this card he should record all tools necessary for the complete tooling of the part in question. A form for such record is shown in Fig. 113. (See also Fig.

87.) It will also be found convenient for the tool-room foreman to have a cross index of the machinery inventory, arranged by kind of tool, so that he may know where the machines of any one kind are located, and the total number of each kind of machine in the entire plant. A form for such record is shown in Fig. 114.

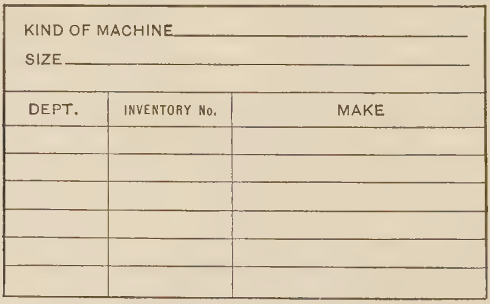


TOOLING RECORD FOR PART No. ______

OPERATIONS	TOOLS REQUIRED

Fig. 113.—Record of tools, jigs, etc., required to machine a given part. White card, 6 inches wide, 4 inches high.

251. Identifying Different Brands of Tool Steel.—The different brands of tool steel are best identified when the steel is still in the bar stock by running narrow strips of paint lengthwise along the bar and having a board hung up in the tool-room on which is listed the name of the brand of steel, corresponding to each colored line or combination of colored lines. After the bar stock has been formed into cutting tools, it is desirable to have the brand of steel and the shape of the tool stamped on the tool itself, using certain symbols or numbers to designate



KIND OF MACHINE ______

SIZE ______

DEPT.	INVENTORY No.	MAKE

Fig. 114.—Record showing location of all machines of any one kind and size. White card, 6 inches wide, 4 inches high.

the various brands and shapes. These stamped symbols, numbers or letters, must be placed on some part of the tool where they will not be obliterated by grinding on re-forging.

Detailed instructions as to the heating and quenching of each brand should be permanently posted in that part of the shop where this work is done, and strict adherence to these instructions should be enforced.

252. Check System.—In keeping track of withdrawals of tools by employees, the double brass check system as suggested by Mr. Perrigo will be found better than the single check system. In the double check system, there are two hooks provided for each employee; next to these two hooks is a label holder in which can be slipped a small strip of paper or card bearing the name of the employee, corresponding to a certain tool-check number. When an employee first reports for work, he is given a supply of, say, 10 round brass tool checks, and 10 square checks bearing the same number are hung on one of the hooks opposite his name. As soon as he calls for a tool, he presents one of his round checks. This is hung on the vacant hook. At the same time one of the square checks is taken off and placed in the tool rack, case, or drawer from which the tool is taken. When he returns the tool, he is given back his round check, and the square check is taken from the rack, case, or drawer into which it had been placed as a substitute for the tool. This system enables the tool-room foreman to tell by the number of round checks hanging on any man's hook just how many tools he has out. In the single check system, only a single check is used, and is substituted for the tool. In this system the foreman cannot tell how many tools a man has out without looking practically through the whole tool-room or keeping an additional written record.

253. Bolts, Clamps, Washers and Nuts for "Setting Up."—It is desirable to keep the floor and benches in the machine shop clear of bolts, washers, nuts, and clamps used in setting up pieces in the machine tools. A good method of identifying all such bolts, clamps, etc., is to have them painted a bright color, such as red, blue, or green, which immediately designates them as tool equipments. Many shops allow these bolts, washers, and clamps to be thrown indiscriminately into drawers of benches or shelves. A much better plan is to provide specially designed storage places for them. Fig. 115 shows a tool-room section so designed, as used by the Tabor Manufacturing Company of

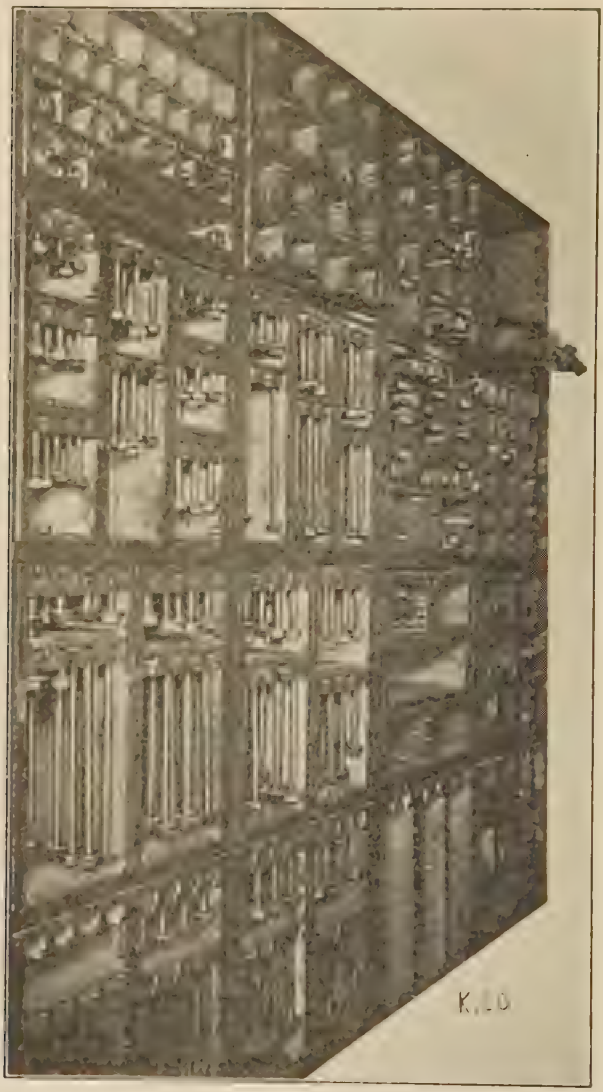


Fig. 115.—Tool-room section made up of tiers of racks, and each compartment subdivided with boxes labeled with brass plates, giving the size and symbol of the bolts contained therein. Particular attention is called to the method of stocking the bolts, the sizes and lengths of the bolts regulate the sizes of the boxes. Pegs are provided on the front of the bottom beveled edge for the workman's checks.

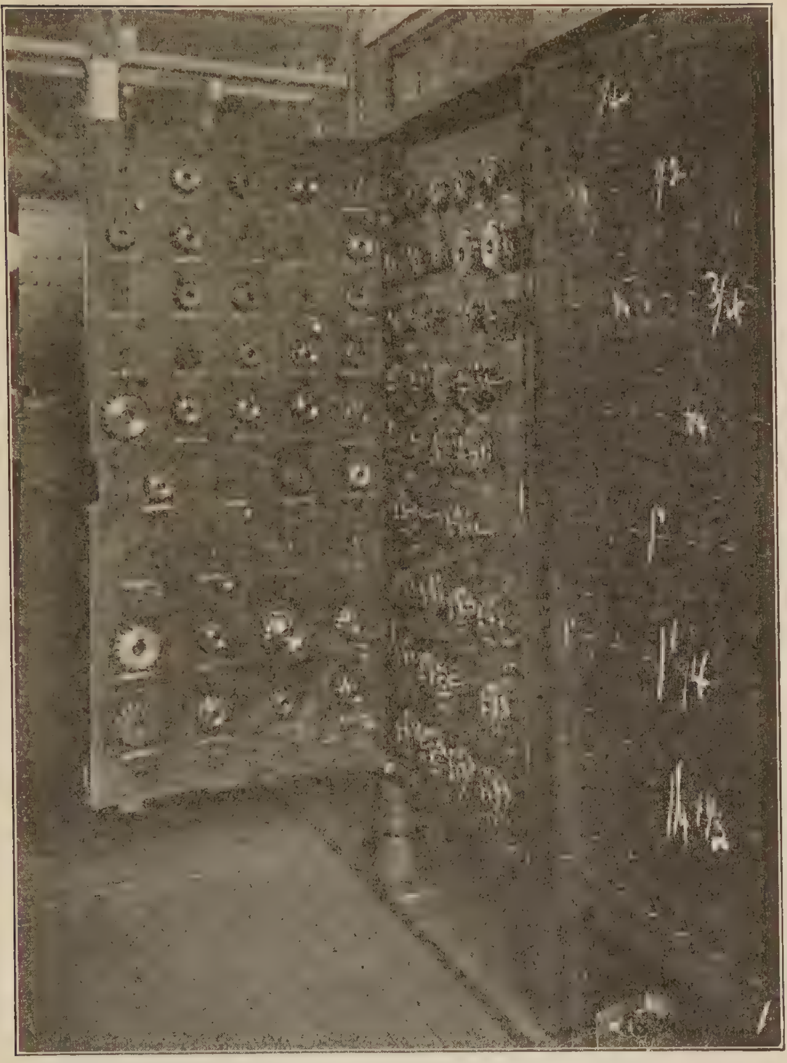


Fig. 116.—Tool-room section made up of a swinging-door cabinet, containing six doors, which swing in and out, giving twelve surfaces for stocking tools. This arrangement facilitates convenience in handling, and permits stocking the greatest number of tools for the floor space occupied. The tools are carried on screw hooks, and beneath each hook is placed a brass plate giving the size and symbol of the tool, and in close proximity to the plate is located the check hook for carrying the workman's check.

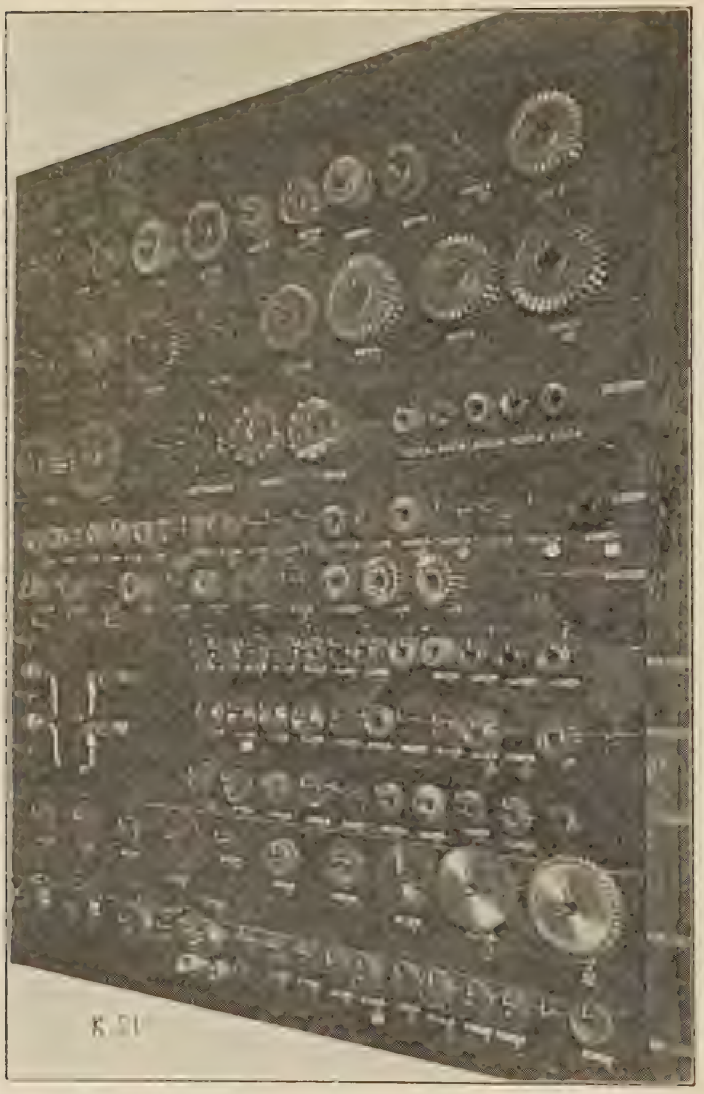


Fig. 117.—Sliding-door racks for tool-room. Each hook labeled with a brass plate giving the size and symbol of the tool. In close proximity to the plate is the check hook for carrying the workman's check. These doors serve the same purpose as the swinging-door cabinets. They are set up in groups of six with twelve inches space between each door, and mounted on wheels, and travel in and out on a track, and are held in an upright position by overhead guides, similar to any sliding-door equipment.

Philadelphia. This company keeps all of these parts in the tool-room.

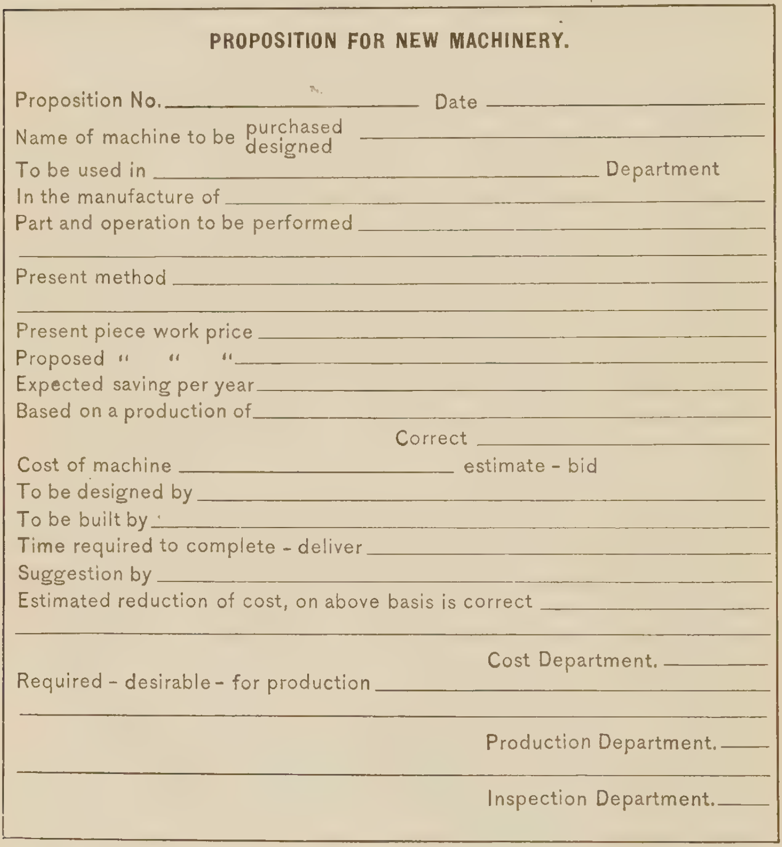
254. Storing Tools.—The problem of storing a large number of tools into a small space, at the same time making it possible to get a rapid and comprehensive view of all of the tools, is one which can be met by the designing of special fixtures for holding the tools. This problem is also well met by the Tabor Manufacturing Company in the construction of sets of boards, six to a set, swinging around a center column, such as shown in Fig. 116, and in a series of sliding frames suspended from barn-door type of trolley hanger, as shown in Fig. 117.

In general, the principle of concealing as little as possible from sight in a tool-room is one which should be observed in designing fixtures for tool storage, hence it will be advisable to avoid closed drawers for storage purposes, and to utilize open shelves as much as possible. Shallow shelves with partition strips separating the tool compartments, and a slope toward the front, facilitate the removal and return of the tools. Space should always be provided for the workmen's checks as substituted for tools withdrawn.

255. Selection of Machines.—In the matter of machine tool equipment there needs to be constant study in the shop as to when it is best to use a general purpose non-automatic machine, when to use a semi-automatic general purpose machine, and when to use single purpose non-automatic or single purpose automatic machines. The question of when to use one or the other types of machines can only be settled after a careful investigation of cost of machines of various types that will answer, and the cost of tools required with each type, as well as the time in which each type of machine will do the work.

As regards the use of special machines, there is no doubt but what their adoption enables manufacturers in the United States, producing articles made of iron and steel, not only to compete with foreign makers but to export. The high price of labor in America, as compared with wages abroad, forms a constant incentive to American manufacturers to look for appliances that will reduce their cost of production. The result is that frequently machines that are first introduced as special finally in some cases become standard, as a result of modifications in various ways.

Within recent years, machines used in connection with press working of metals and the working of hot metals have undergone a development fully equal to that which has taken place in machinery of the strictly machine-tool class. Presses of various types are now found in all improved shops, and are indispensable if the output is a standard article and produced in large quantities, such as sewing-machines, typewriters, agricultural implements, parts of automobiles, etc. A few years ago the use of presses was confined to the manufacture of sheet metal goods, and while most of the presses now in use are still cutting or forming articles from the sheet or strip, the scope is broadening, especially in the direction of forming bar metals, thereby simplifying and cheapening operation of special presses.



PROPOSITION FOR NEW MACHINERY.

Proposition No.________________ Date ________________

Name of machine to be purchased / designed ________________

To be used in ________________ Department

In the manufacture of ________________

Part and operation to be performed ________________

____

Present method ________________

____

Present piece work price ________________

Proposed " " " ________________

Expected saving per year ________________

Based on a production of ________________

Correct ________________

Cost of machine ________________ estimate - bid

To be designed by ________________

To be built by ________________

Time required to complete - deliver ________________

Suggestion by ________________

Estimated reduction of cost, on above basis is correct ________________

____

Cost Department. ________

Required - desirable - for production ________________

____

Production Department. ________

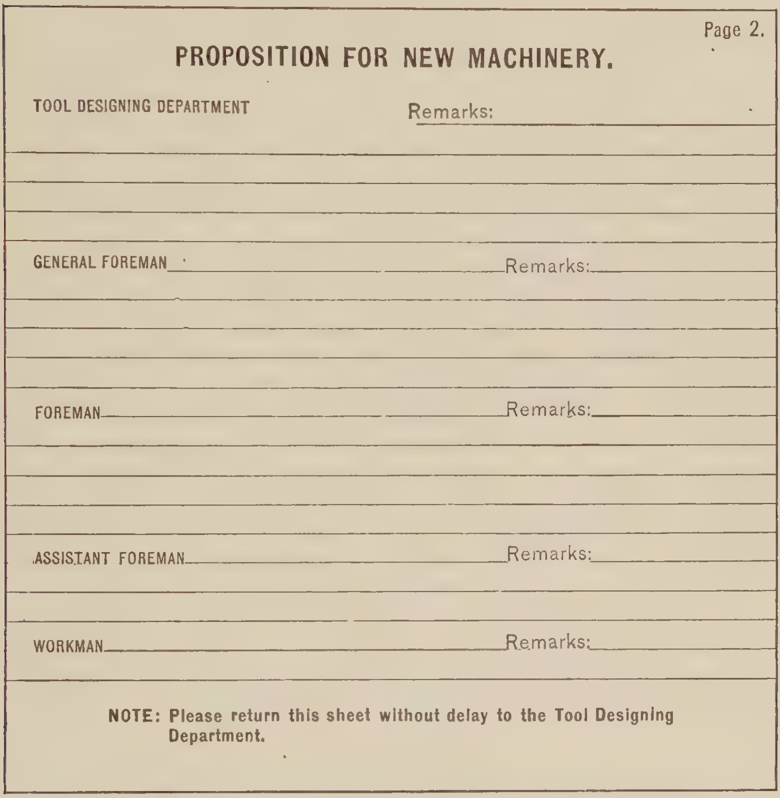
____

Inspection Department. ________

FIG. 118.—Page 1 of proposition to introduce new machinery. White bond paper. Four-page folder, each page 8 1/2 inches wide, 11 inches high.

256. Proposals for New Machinery Equipment.—Figs. 118 to 120 inclusive illustrate a form used in a large manufacturing establishment in considering proposals for introducing new machine tools or special machinery.

Figs. 118 and 119 are printed on the inside of a four-page folder of about the proportions and shape of a foolscap sheet, and are



Page 2.

PROPOSITION FOR NEW MACHINERY.

TOOL DESIGNING DEPARTMENT Remarks:

GENERAL FOREMAN Remarks:

FOREMAN Remarks:

ASSISTANT FOREMAN Remarks:

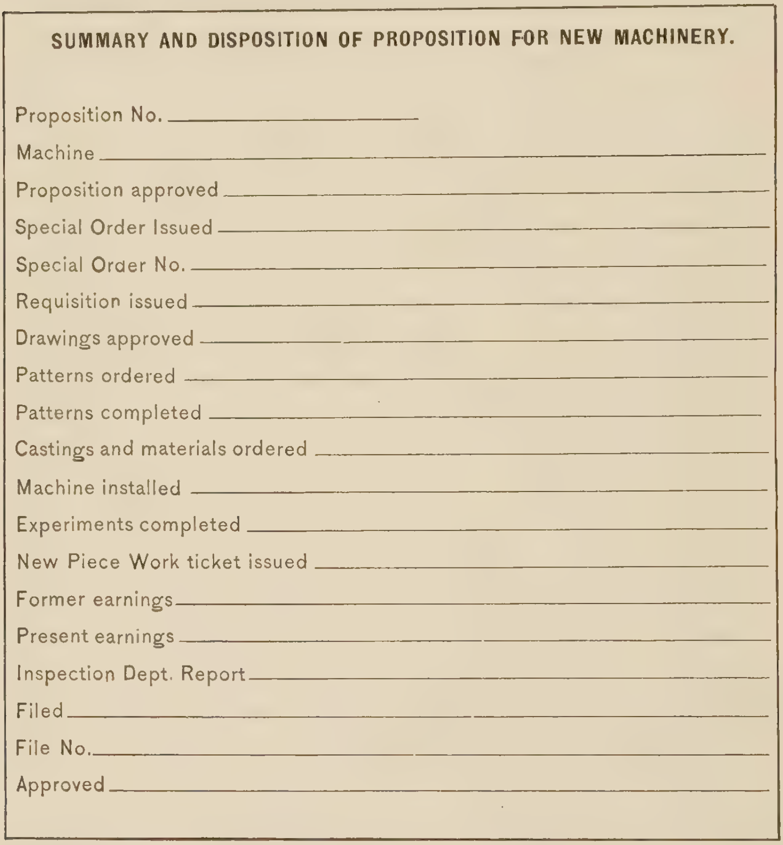
WORKMAN Remarks:

NOTE: Please return this sheet without delay to the Tool Designing Department.

Fig. 119.—Page 2 of proposition to introduce new machinery (see Figs. 118 and 120).

a record of the anticipated advantages which would accrue from introducing the new machine. It will be noticed that opinions are asked for from a number of individuals and departments, including cost department, production department, inspection department, tool-designing department, general foreman, assistant foreman, and the workman. After these complete expressions of opinions, some of which may, of course, be prejudiced and must be taken for what they are worth, the report is submitted to a committee which selects from the various proposals those which seem to be most advantageous.

Fig. 120 is printed on the outside front page of the folder.



SUMMARY AND DISPOSITION OF PROPOSITION FOR NEW MACHINERY.

Proposition No. ____________________

Machine ____________________

Proposition approved ____________________

Special Order Issued ____________________

Special Order No. ____________________

Requisition issued ____________________

Drawings approved ____________________

Patterns ordered ____________________

Patterns completed ____________________

Castings and materials ordered ____________________

Machine installed ____________________

Experiments completed ____________________

New Piece Work ticket issued ____________________

Former earnings ____________________

Present earnings ____________________

Inspection Dept. Report ____________________

Filed ____________________

File No. ____________________

Approved ____________________

Fig. 120.—Summary and results of proposition to introduce new machinery. (Outside cover to Figs. 118 and 119.) (See Figs. 118 and 119.)

REFERENCES

Tuck School Conference on Scientific Management, pp. 155–175.

Evans: "Cost keeping and Scientific Management," Chapter XIII.

Parkhurst: "Applied Methods of Scientific Management," Chapter VI.

Carpenter: "Profit-making Management," Chapters V, VI and VII.

Perrigo: "Modern Machine-shop Construction, Equipment and Management," Chapter XXIX.

CHAPTER XX

SHIPPING AND RECEIVING DEPARTMENTS

257. Relation of Shipping and Receiving to Other Departments.—In most establishments shipping and receiving are under the same general head. In others purchasing and receiving are under the same department, while in still others the receiving department is an independent department reporting direct to the factory manager.

258. Copies of Orders to be Sent to Shipping Department.—The shipping department should receive a copy of every order which the department is expected to ship, such copy containing all the information necessary to get out and pack all items belonging to that order. The shipping department's files of unfilled orders will be classified according to the order classification scheme of the company. Thus there may be contract orders on one file, supply orders on another, etc. Usually the shipping department will want to put express orders on a separate file board from freight shipments. All reference orders or changes or additional information should be written on blanks bearing the same order number as the original order.

259. Notice of Items Ready for Shipment.—The shipping department should be furnished a weekly list of large orders or contract orders which it is expected to ship the following week if the business is one involving the shipment of large contracts, so that proper arrangements can be made for ordering in cars.

260. Stores and Inspection Records Prior to Shipment.—In order to keep complete stock records it is necessary that all parts should pass into stock and be recorded as having been received from the shop before they are shipped out. When items on any order sufficient for a shipment are ready, the stock department sends its order copy to the shipping department, with a check opposite the items that are ready for shipment, together with date. If the parts are not inspected parts sent in quantity into the stock-room, but represent large machines or groups of parts which do not actually go into the stock-room but are shipped direct from the shop floor, then the stock-room copy of the order should be stamped by the floor inspector. The shipping department must see that for all articles shipped direct from the shop floor there is an inspection record. In some factories the inspector's report is sent to the shipping department as a notice that goods are ready for shipment. Orders for small supplies and repair parts coming direct from stock warehouse are not usually marked "Inspected," as these parts are usually inspected in quantity by an inspection department which examines all lots of small parts just before they are turned into stock.

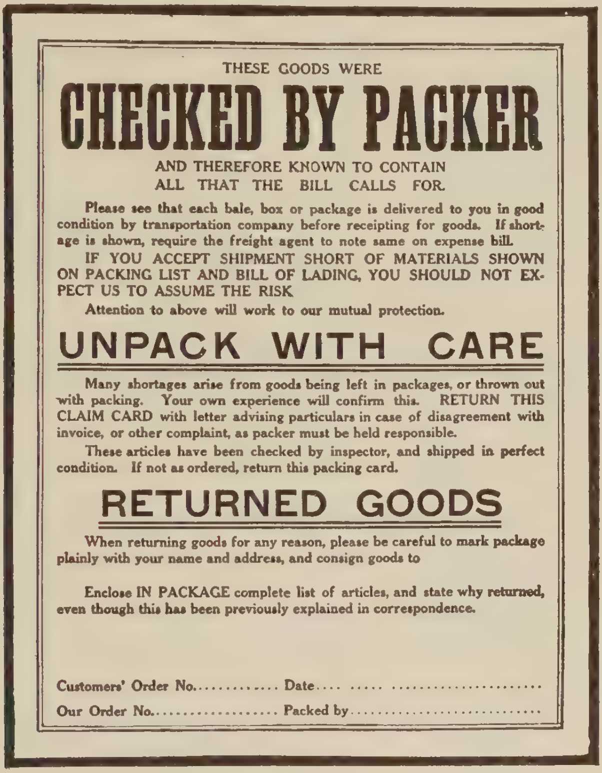
261. Packing Rooms.—It is well to provide a room or space with a number of bins of various sizes closely adjacent to the packing and loading space. The stock department puts into these bins the items which they have ready for shipment for various orders, hanging a tag on each bin, with the order number marked on these tags, and a large tag marked "Ready" on such bins as contain goods ready for shipment.

When the shipping department receives the stock-room's copy of an order, indicating that the goods are ready to ship, the shipping department order copy is removed from the regular file and put into a temporary file, the stock department's copy is stamped by the shipping department and is then returned to the stock-room. The shipping department's stamp does not necessarily mean that they have shipped the goods that day, but indicates that they have noted that the goods are ready and are proceeding to the best of their ability to get them shipped. When shipping department is ready to begin packing, a shipping department clerk takes the shipping department order temporary file, goes to the bins in the storeroom and to the shop floor if necessary, and checks off by items all material called for. He then has the packers bring the material to the loading-room or platform and endorses on the order how it is packed, viz., the number of boxes, barrels, or crates. If the order is complete, he so marks it and turns it over to the clerk who writes out the railroad receipts and packing lists, or, in a smaller establishment, does this himself. Packing lists are usually written out in manifold as are also railroad receipts, there being usually three copies.

262. Packing Cards and Lists.—In each package there is inserted a packing card similar to Fig. 121. This contains customer's order number, shipper's order number, date packed and by whom packed, and give full information as to what to do in case of shortage or breakage or claims covering defects.

Fig. 122 shows a form for packing list, one of which is placed in the package, and one sent by mail to the consignee; another copy goes to the production department, which visés same, and then sends it to the stores department.

Fig. 123 shows a form for freight receipt which is signed at the railroad receiving depot, and is followed by the railroad company's regular bill of lading.



THESE GOODS WERE

CHECKED BY PACKER

AND THEREFORE KNOWN TO CONTAIN
ALL THAT THE BILL CALLS FOR.

Please see that each bale, box or package is delivered to you in good condition by transportation company before receipting for goods. If shortage is shown, require the freight agent to note same on expense bill.

IF YOU ACCEPT SHIPMENT SHORT OF MATERIALS SHOWN ON PACKING LIST AND BILL OF LADING, YOU SHOULD NOT EXPECT US TO ASSUME THE RISK.

Attention to above will work to our mutual protection.

UNPACK WITH CARE

Many shortages arise from goods being left in packages, or thrown out with packing. Your own experience will confirm this. RETURN THIS CLAIM CARD with letter advising particulars in case of disagreement with invoice, or other complaint, as packer must be held responsible.

These articles have been checked by inspector, and shipped in perfect condition. If not as ordered, return this packing card.

RETURNED GOODS

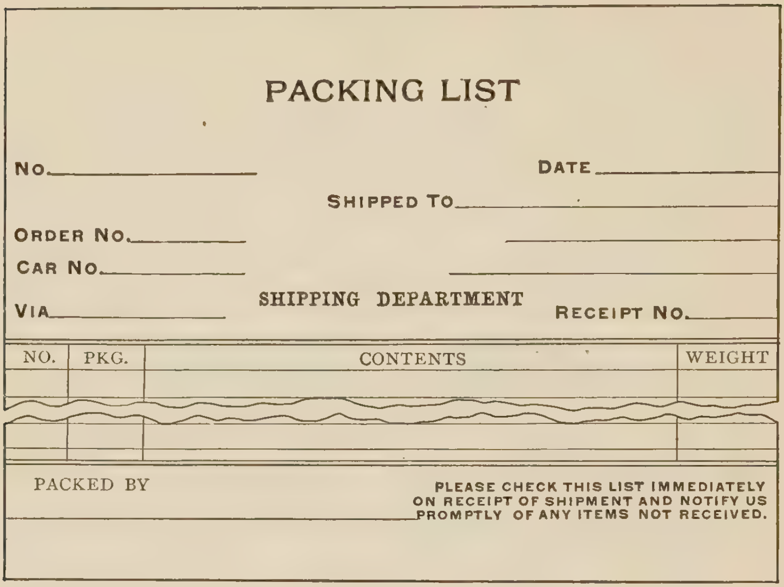
When returning goods for any reason, please be careful to mark package plainly with your name and address, and consign goods to

Enclose IN PACKAGE complete list of articles, and state why returned, even though this has been previously explained in correspondence.

Customers' Order No............ Date.... ....
Our Order No.................. Packed by..........................

Fig. 121.—Packing card. Yellow card, 7 inches wide, 9 inches high

263. Shipping Records.—As soon as packing lists have been written, entries are made into a shipping record book of form, similar to that shown in Fig. 124. This book contains columns showing date of shipment, number of sheets to the order, how shipped, car number, whether freight was prepaid, date paid,



PACKING LIST

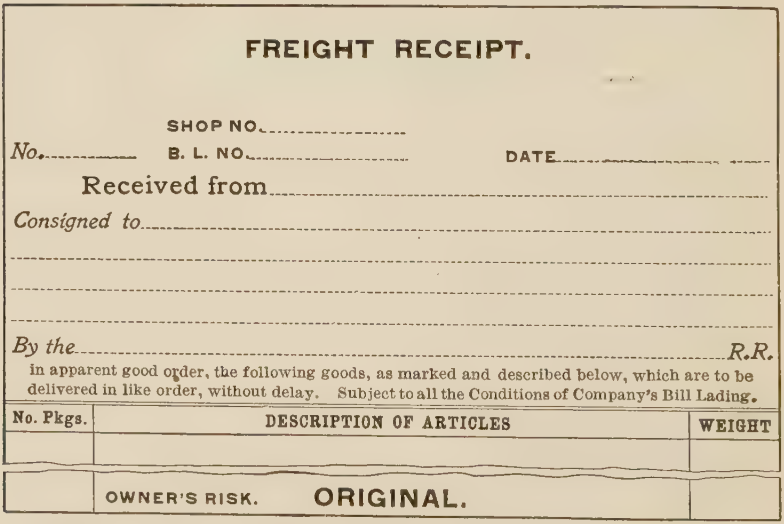
No.
DATE
SHIPPED TO
ORDER NO.
CAR NO.
VIA
SHIPPING DEPARTMENT
RECEIPT NO.

NO.	PKG.	CONTENTS	WEIGHT

PACKED BY

PLEASE CHECK THIS LIST IMMEDIATELY ON RECEIPT OF SHIPMENT AND NOTIFY US PROMPTLY OF ANY ITEMS NOT RECEIVED.

FIG. 122.—Packing list. One copy goes to consignee by mail, one copy is placed in package, and another copy goes to production and stores departments. White paper, 6 1/2 inches wide, 8 1/2 inches high.



FREIGHT RECEIPT.

SHOP NO.
No.
B. L. NO.
DATE
Received from
Consigned to

By the *R.R.*

in apparent good order, the following goods, as marked and described below, which are to be delivered in like order, without delay. Subject to all the Conditions of Company's Bill Lading.

No. Pkgs.	DESCRIPTION OF ARTICLES	WEIGHT
	OWNER'S RISK. **ORIGINAL.**	

FIG. 123.—Freight receipt. Buff paper, 6 1/2 inches wide, 8 1/2 inches high.

name of consignee, whether a test record was written or not, a column for completed shipments and one for partial shipments, and a column showing the date on which the packing list and order copy were received by the billing department, and by whom they were received.

SHIPPING RECORD.

DATE	Number of Sheets	ORDER NO.	SHIPPED VIA OR CAR NO.	PREPAY		NAME	TEST RECORD Red indicates no test necessary	SHIPPED		REC'D IN OFFICE		
				Check Indicates Prepay	Date Paid			Complete	In Part	Date	By Whom	

FIG. 124.—Form for shipping record. White bond paper, 8 inches wide, 10 1/2 inches high, ruled in red and blue.

The packing lists, as previously mentioned, are made out in triplicate. One copy is attached to the shipping department's order copy, and, if a freight shipment, is retained in the shipping office until railroad receipt comes back. Packing lists for express shipments are sent to billing department the same day as the shipping department order copies. Those for freight shipments are not sent to billing department until railroad receipt is returned to shipping department.

If part of a company's sales are filled by direct shipments from some other party to the consignee, the following routine will serve to keep the shipping records complete: All shipping memoranda and bills of lading covering direct shipments to customers from outside suppliers are sent by the general office to the shipping department as soon as received. A packing list form is then filled out in the usual manner, excepting that it is endorsed, "Direct Shipment," together with date of shipment and from where shipped. The order copies are then handled in exactly the same manner as for shipments made from the shop.

264. Shipping Program for Carload Shipments.—Mention has already been made of the fact that the shipping department should receive a weekly advance shipping program covering carload shipments, such programs being prepared by the order department as a result of consultation with the production department. As soon as the shipping department has ordered a car an entry is made in a book entitled "Carload Shipments." This book may conveniently be of the form shown in Fig. 125. It has a column covering "Shipped to," "Machines," "Car Initials and No.," "Date Ordered," and "Date Left." The first date in the date column indicates the date the car was ordered.

CAR LOAD SHIPMENTS

TO	MACHINES	CAR		DATE	ROUTE	CAR
		INITIAL	No.			

Fig. 125.—Record of car-load shipments. White bond paper, 8 inches wide, 10 1/2 inches high, ruled in red and blue.

CAR RECORD

CAR		DELIVERED ON OUR SWITCH	SET	LOADED OR UNLOADED	TAKEN OUT	SHIPPED TO OR RECEIVED FROM	REMARKS
INITIAL	No.						

Fig. 126.—Record for all incoming and outgoing cars. White bond paper, 8 inches wide, 10 1/2 inches high, ruled in red and blue.

This item is important as it usually takes some days to get a car in. As soon as the car is "set," entries are made showing the car initials and number. The date on which the car comes in is not provided in the form shown, but may be a desirable record. A second entry is made in the date column, indicating the date the car left. A column is also provided for the route, and one for the kind of car.

265. Car Records.—A separate record is kept in another book entitled "Car Record," covering all cars coming in and going out. This record is useful for reference in matters of demurrage, etc. A form for this record is shown in Fig. 126. It has columns for car initials, car number, date delivered on switch, date "set," date loaded or unloaded, date taken out, party shipped to or received from, and a column for remarks. Cars going out may be distinguished from those coming in by entering the name in the column headed "Shipped to or Received From," in red for outgoing cars and in black for incoming ones. In some cases the same car that has come in is used for an outgoing shipment. In such cases two entries—one in red and one in black—are made in the column headed "Shipped to or Received From." One set of entries in all the other columns will serve for both shipments. The "Remarks" column is used for entering the purchase order numbers on any carload items coming in on a purchase order, and for other memoranda.

FREIGHT PAYMENTS. "INCOMING."

DATE OF NOTICE	MONEY HANDED TO DRIVER	DATE PAID	WEIGHT	RATE	AMOUNT	R.R.	ORDERED FROM OR SHIPPED BY	SHOP P.O. OR MATR'L.	PLACE SHIPPED FROM	REC'D IN OFFICE		
										Date	By Whom	

FIG. 127.—Record of freight payments on incoming goods. White bond paper, 8 inches wide, 10 1/2 inches high, ruled in red and blue.

266. Freight Payments.—Freight bills are entered in a book called "Freight Payment Book." This has the opposite pages headed respectively "Incoming" and "Outgoing" (see Figs. 127 and 128). On the "Incoming" page there is a column for date of notice, one for date the money was handed to driver (where such is the case), one for date paid, one for weight, one for rates, one for amount, name of railroad, ordered from or shipped by, shop or purchase order number to which material applies, also column covering date received in office and by whom.

On the "Outgoing" page there are columns covering way-bill, date, date money handed to driver, date paid, weight, rate, amount, shipped via, shipped to, order number, destination, and a column headed "Date Received in Office and by Whom." This book serves to keep track of all bills in drivers' hands, and also serves shipping department as a receipt from the office for freight bills. Items covering material shipped direct by other companies are entered in the same manner as shipments from the factory, with some designating mark to show that the shipment was not from the factory, but was a direct shipment from an outside company. As soon as shipping data are received covering such direct shipments, memoranda of such information as shippers' order number, route, and amount of freight paid, are entered on the shipping department's office copy of packing list.

FREIGHT PAYMENTS. "OUTGOING"

	W/B DATE	MONEY HANDED TO DRIVER	DATE PAID	WEIGHT	RATE	AMOUNT	SHIPPED VIA	SHIPPED TO	SHOP NO.	DESTINATION	REC'D IN OFFICE		
											Date	By Whom	

FIG. 128.—Record of freight payments on outgoing goods. White bond paper, 8 inches wide, 10 1/2 inches high, ruled in red and blue.

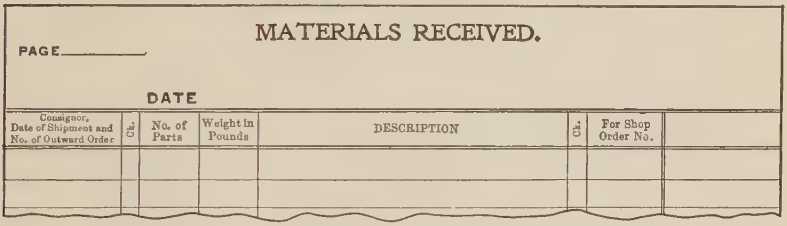
267. Record by Serial Numbers of Machines Shipped.—The shipping department usually keeps a record also by serial numbers of machines of various types, showing to whom the machine of a certain serial number was shipped, when shipped, reference to test record, etc. Another record usually kept in the shipping department is a record of shipping weights of machines or other products of various types.

268. Routing, Classification and Rates.—The head of the shipping department should be sufficiently relieved of clerical routine to enable him to devote some time daily to the matter of classification and routing of shipments, matters which most establishments are inclined to leave to the railroads. Proper files for taking care of railroad tariffs, and a careful study of them by the head of the shipping department, are likely to result in saving of freight charges and avoidance of delays in shipment.

A follow-up system should be used in connection with any freight claims, so that a claim is never neglected for any considerable period by the company, even though the railroad may be inclined to pigeon-hole it.

269. Receiving Department.—As before stated, in most manufacturing establishments the receiving of incoming goods is handled by a man or a group of men who come under the supervision of the shipping department. Some factories make the receiving department a part of the purchasing department. Some others make an independent department of the receiving department. The last-named method is perhaps preferable to making receiving subordinate to purchasing. Where receiving and purchasing are one department, there is a tendency to be somewhat lax in checking up incoming goods by reason of the easy access on the part of the receiving clerks to purchase records and invoices.

The receiving department is usually provided with a carbon copy of all purchase orders. For convenience in checking in items such as castings, etc., of which a large number and variety are purchased from one source of supply, it is usually desirable to have the purchasing department write separate orders covering each pattern number rather than to specify a number of different patterns on the same order. This makes it easier to endorse partial deliveries on the receiving department's copies of the purchase orders, and makes it simpler to remove completed orders from the receiving department's file of orders representing goods still to be received.



MATERIALS RECEIVED.

PAGE__________

DATE

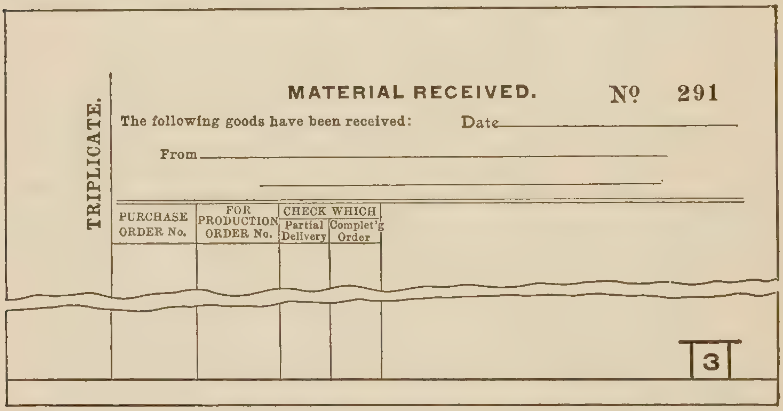
Consignor, Date of Shipment and No. of Outward Order	Ck.	No. of Parts	Weight in Pounds	DESCRIPTION	Ck.	For Shop Order No.	

FIG. 129.—Receiving department's report of form in which receipts from various sources are listed on one sheet. White bond paper, 8 1/2 inches wide 11 inches high.

270. Reports of Material Received.—Fig. 129 shows a form of receiving department report covering materials received, which is the form such report usually takes when the items received are all listed on a single report. A better plan is to write out a separate receipt slip covering each consignment. Fig. 130

shows such a form as prepared for use with an autographic register machine. The form shown is written in quadruple, one copy being sent to the purchasing department, one copy to the stores department, one to the production department, and one remaining on file in the receiving room. It will be noted that in this form there are spaces printed for the date, the name and address of the shipper, the purchase order number, the production order number, two columns for checks, the first being headed "Partial Delivery," the second headed "Completed Order," and a wide space for listing the items, weights, etc.

271. Reports of Castings Received.—Fig. 131 shows a similar form as used in recording castings received. This form provides space for date, and columns headed respectively, "Number of Pieces," "Pattern Number," "Material," "Purchase Order Number," "Foundry," "Production Order Number," two columns for checks, the first being headed "To Shop," the second "To Warehouse"; and two columns headed "Warehouse Report," the first of these being headed "Bin Number," the second headed "Balance on hand, including this lot." The receiving clerk puts a check in the column designating whether he has sent castings to the shop or to the castings warehouse. The receiving department sends one copy to the purchasing department, one copy to the production department, retains one copy for itself, and sends one copy to the stores record clerk; this last copy going first to



TRIPLICATE.

MATERIAL RECEIVED. № 291

The following goods have been received: Date

From

PURCHASE ORDER No.	FOR PRODUCTION ORDER No.	CHECK WHICH	
		Partial Delivery	Complet'g Order

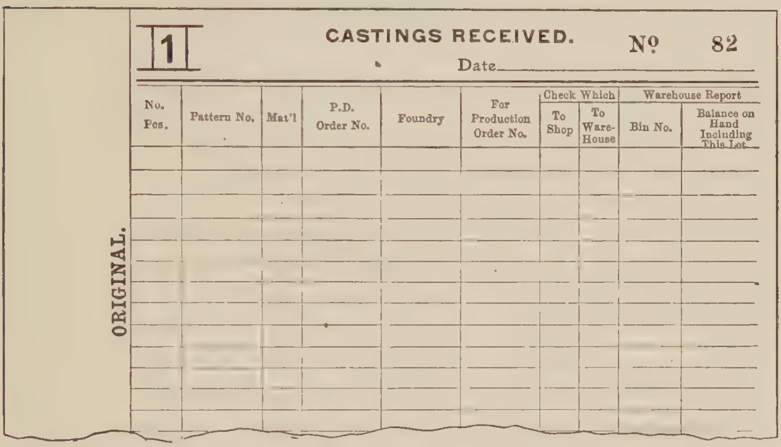
3

FIG. 130.—Receiving departments report of form in which a separate report is made of each vender's shipment or delivery. White bond paper, 8 inches wide, 5 3/4 inches high.

the castings warehouse where the warehouse-man enters the number of the bin into which he has put the castings, and the balance on hand, including this lot He is instructed to make an actual count on such castings as he receives a new supply of. In this manner the stores records are checked by actual count.

272. Express Charges.—Fig. 132 shows a form used in reporting express charges to the accounting department by the receiving department. This form gives the name of the shipper, the nature of the package, the date, the route, charges, purchase order number, and by whom received.

In manufacturing establishments where many of the production orders cover work on castings which come to the receiving department in small lots at a time, it is convenient to make the receiving department the storage place for the tag production orders which are awaiting arrival of castings before work can be done on them. The receiving department will arrange these tags in filing boxes according to the name of the foundry from whom the castings are to come, and under the foundries will arrange the tags by pattern numbers. As soon as a lot of castings arrives, the first thing the receiving clerk does is to look over the tags under the guide card bearing the name of foundry in question to see whether he has shop production tags on file covering any of the castings received. In case he has tags on file and sufficient castings as called for by the tags,



ORIGINAL.

1

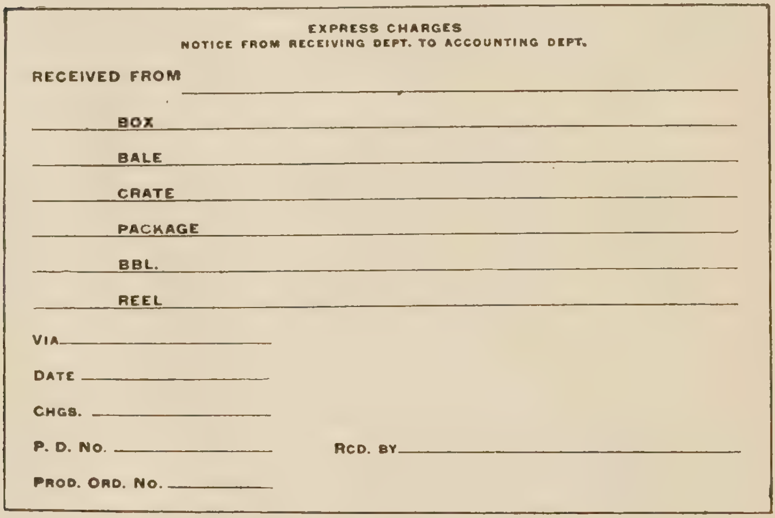
CASTINGS RECEIVED. Nº 82

Date____________________

No. Pcs.	Pattern No.	Mat'l	P.D. Order No.	Foundry	For Production Order No.	Check Which		Warehouse Report	
						To Shop	To Ware-House	Bin No.	Balance on Hand Including This Lot

FIG. 131.—Receiving department's report of castings record. White bond paper, 8 inches wide, 5 3/4 inches high.

he will send the castings into the shop instead of into the storage at the castings warehouse. In case there are not enough castings to fill the order the normal procedure would be to send the castings to the warehouse, noting on the production tag in the space provided for that purpose how many castings have been received, and when sent to the warehouse. In case there is a rush slip attached to the production tag, the production department is notified at once, and that department will decide whether a partial delivery is to be made to the shop, such partial delivery being accompanied by a detachment tag, the writing out of which is noted on the regular tag on the place provided therefor. Detailed illustrations will be found in the chapter on "Production or Planning Department."



EXPRESS CHARGES
NOTICE FROM RECEIVING DEPT. TO ACCOUNTING DEPT.

RECEIVED FROM ______

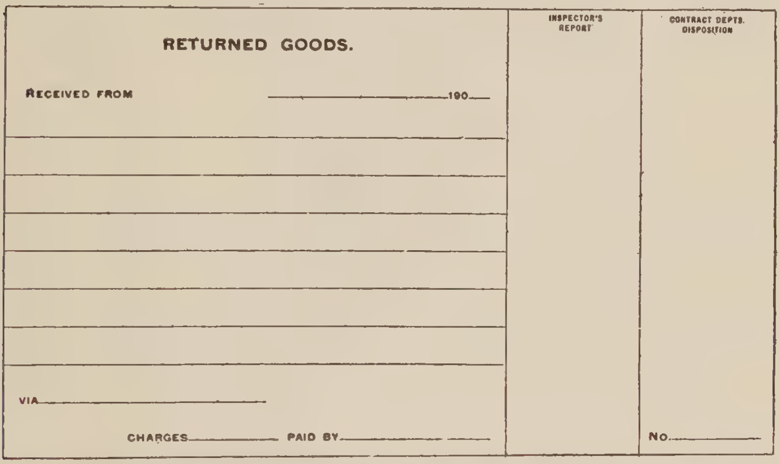
______ BOX ______
______ BALE ______
______ CRATE ______
______ PACKAGE ______
______ BBL. ______
______ REEL ______

VIA ______
DATE ______
CHGS. ______
P. D. NO. ______ RCD. BY ______
PROD. ORD. NO. ______

FIG. 132.—Receiving department's notice to accounting department of express charges. White bond paper, 6 inches wide, 4 inches high.

273. Returned Goods.—In many establishments an important phase of the business is that which has to do with goods returned for repairs or for exchange or for credit. The following system was devised to take care of such cases:

The receiving department tags all returned goods with identifying tags (which show name of shipper), and writes out a returned goods ticket, shown in Fig. 133 in triplicate, entering on this ticket the following information: the date, the party returning the goods, what the goods consist of and quantity, whether transportation was paid by shipper or by consignee, and if by the latter, the amount of payment. The original ticket is then sent with the goods to the inspection department, who will state the condition of the goods on the ticket. In making this statement the inspection department will specify, first, whether goods are equal to new stock in their present condition; second, whether by doing work on them they may be made equal to new; third, whether, if neither of the above conditions exist, they have any value as second-hand goods; fourth, whether they should be scrapped. The inspection department then sends original ticket to the general office, and places the goods into a space provided for that purpose, such space being under the supervision of the stores department. A duplicate ticket follows the same course as the original, except that it is sent finally to the head of the supply department instead of to the general office. The triplicate copy remains in the book in the receiving department, and all endorsements as to disposition, which appear on the original, are copied on to the triplicate in the receiving department as soon as the original is returned to the receiving department. Disposition of these goods may involve either the rendering of a credit memorandum, the issuing of a shop order, or the con-



RETURNED GOODS.

RECEIVED FROM ____________ 190__

VIA____________

CHARGES________ PAID BY____________

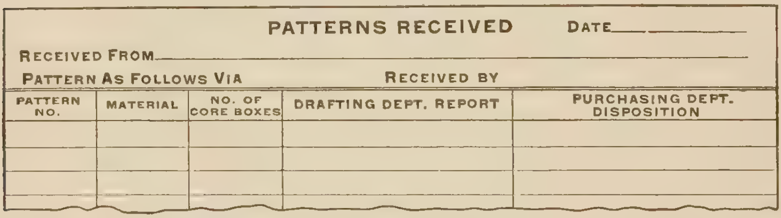
INSPECTOR'S REPORT

CONTRACT DEPTS. DISPOSITION

NO.________

FIG. 133.—Returned goods ticket. White bond paper, 8 1/2 inches wide, 5 inches high.

duction of further correspondence by either the general office or the supply department. As soon as the general office determine on disposition, such disposition is entered on the original copy which is sent to receiving department, who, after making triplicate agree with original, return original to general office for file. Whenever the disposition of the returned goods involves work on the part of the shop, regular production tags are to be written out by the production department. On presentation of such tags, the goods will be delivered by the stores keeper. When the goods have been put into condition to put in stock, the inspector makes proper indorsement on tags accompanying the goods; this tag going with the goods into the stock-room, and thence to the stock entry clerks. Such parts as are rejected by the inspector, or such parts as are marked to be scrapped, are put through the regular routine of rejected parts.



PATTERNS RECEIVED DATE

RECEIVED FROM

PATTERN AS FOLLOWS VIA RECEIVED BY

PATTERN NO.	MATERIAL	NO. OF CORE BOXES	DRAFTING DEPT. REPORT	PURCHASING DEPT. DISPOSITION

FIG. 134.—Receiving department's report of patterns received. Blue bond paper, 8 1/2 inches wide, 4 1/2 inches high, ruled in red and blue.

The returned goods ticket, it will be noted, has a space at the extreme right hand, on which is noted the word "Disposition." This column is filled in the general office, and the ticket is then returned to the receiving department. Such goods as are marked "Repair" on the receiving tag are held in the storeroom space provided for returned goods until regular shop-production tags are sent there.

For such goods as are marked "Put in Stock," the stockkeeper will write out a regular production tag, having the inspector endorse it on the back just as though it were a part received from the shop. The tag will then be sent to the stock entry clerks for record.

274. Patterns Received.—Patterns received are reported to drafting department, purchasing department, and production department, on carbon copies of a form shown in Fig. 134, the original of which is kept on file with entries as to checking by drafting department, and disposition as designated by purchasing department. See also Fig. 66, and accompanying text in Chapter XIV.

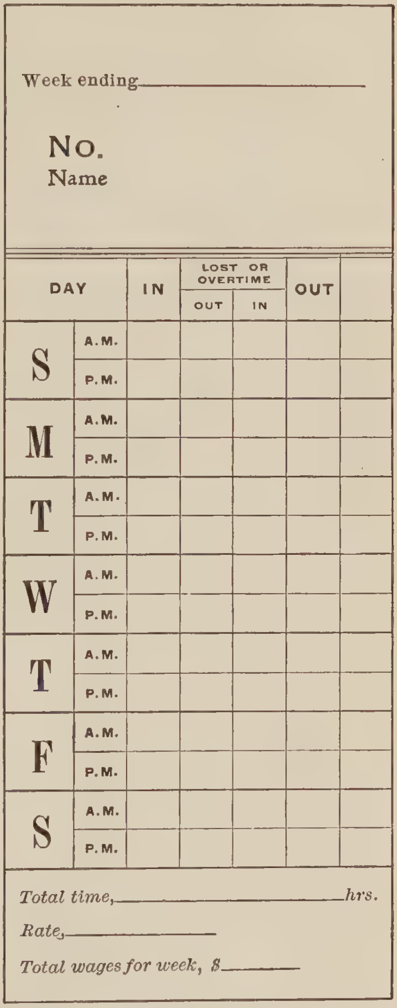
CHAPTER XXI

TIME-TAKING

275. Time-clocks and Numbering Men.—Practically every factory uses a time-clock for the purpose of registering the time of arrival and departure of employees. There is a considerable variety of time-clocks, some using cards and some using strips. There are clocks on the market which have automatic shifts which designate lateness or irregular time by prints of different color or similar designation. Where cards are used in a clock, it is very desirable to use an addressing machine for printing the date, check number, and name of the employee on the cards. Such addressing machines may be used also for printing the same information in the upper right-hand corner of the time-sheets covering observational data taken by shop time-takers where this system of recording men's labor is in vogue. The same addressing machine may be used, omitting the date stamp, to make up a pay-roll list, such pay-roll list being arranged by departments. This necessitates the allotting of a certain excess quantity of men's clock numbers to each department, in order to allow for an increased number of employees in any one department. It is desirable to have considerably more numbers available than there are employees. This may necessitate the use of one or more additional time-clocks in order to provide for all the numbers. There are many advantages in the system, however, which will usually compensate for the additional cost of clocks. One advantage which will be apparent at once is the ease with which the total pay-roll, number of employees, and average wage rate, can be calculated for each department where the check numbers for one department are all close together; for instance, numbers from one to fifty may be lathe hands, fifty to seventy-five, boring-mill hands, etc.

276. Clock Card used as Job Ticket.—The clock cards are used in some factories for recording the nature of the work done by the men. A system for this purpose is as follows: Each workman has a tin box in which he keeps his time-tickets.

The same ticket is used for time-stamp by the time-clock, and for entries describing the work made by the workman himself. One side of the ticket is used for clock stamps, the other side is used for postings by the man. On this latter-named side there are rulings for three days with spaces for a number of entries on each day.



Week ending________________

No.
Name

DAY		IN	LOST OR OVERTIME		OUT	
			OUT	IN		
S	A.M.					
	P.M.					
M	A.M.					
	P.M.					
T	A.M.					
	P.M.					
W	A.M.					
	P.M.					
T	A.M.					
	P.M.					
F	A.M.					
	P.M.					
S	A.M.					
	P.M.					

*Total time,*________________*hrs.*

*Rate,*__________

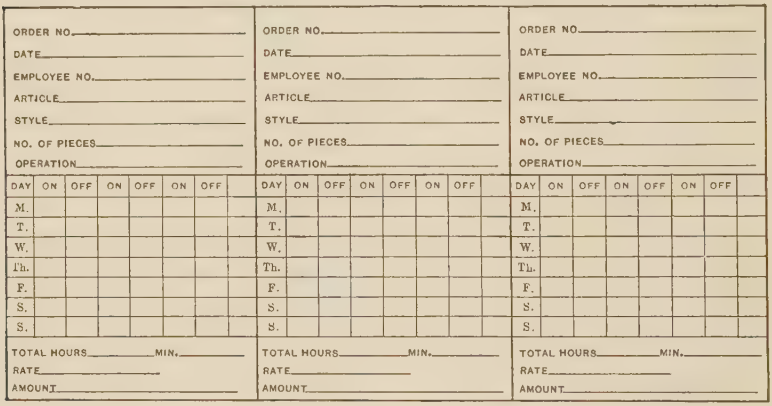
*Total wages for week, $*______

FIG. 135.—Clock time-card with workman's record of orders worked on listed on back of card. Two sets of cards, one yellow and one red, are used, the same card being used on alternate days in the shop and kept in the office for posting on the other alternate days. Brick red card, 2 5/8 inches wide, 7 inches high.

A yellow time-ticket is used on Monday, Wednesday, and Friday, and a red ticket on Tuesday, Thursday, and Saturday. On alternate days the time-tickets are turned in to time-posting clerks, who keep all time-postings up to date. In such a system it is difficult to expect workmen to observe their time more carefully than to the nearest half-hour. An office boy collects the men's time-tickets the first thing in the morning before starting time. At the time of collecting the yellow tickets, say on Tuesday morning, this boy puts into each workman's box his red ticket, these red tickets having been delivered to the same office boy after posting on the evening of the day on which they were posted.

Fig. 135 shows the front of a form of time-card as used with this system. The back (not shown) is ruled for three days' work entries.

In most shops each workman changes jobs a number of times a day, and the clock card will hardly allow sufficient room for the record in such cases, where a single card is used for entries covering an entire week, or even a half-week with the system where cards are changed every other day. The manufacturers of time-clocks have suggested as a way to get around this difficulty the use of job cards in addition to the clock card for attendance. In this system the production or planning department or the foreman or department clerk or time-keeper writes out individual operation or job cards for each workman's labor on each component order, the starting time of one operation being the stopping time of the operation next preceding it. A form of clock card used with this system is shown in Fig. 136.



ORDER NO.
DATE
EMPLOYEE NO.
ARTICLE
STYLE
NO. OF PIECES
OPERATION

DAY	ON	OFF	ON	OFF	ON	OFF	
M.							
T.							
W.							
Th.							
F.							
S.							
S.							

TOTAL HOURS MIN.
RATE
AMOUNT

ORDER NO.
DATE
EMPLOYEE NO.
ARTICLE
STYLE
NO. OF PIECES
OPERATION

DAY	ON	OFF	ON	OFF	ON	OFF	
M.							
T.							
W.							
Th.							
F.							
S.							
S.							

TOTAL HOURS MIN.
RATE
AMOUNT

b

ORDER NO.
DATE
EMPLOYEE NO.
ARTICLE
STYLE
NO. OF PIECES
OPERATION

DAY	ON	OFF	ON	OFF	ON	OFF	
M.							
T.							
W.							
Th.							
F.							
S.							
S.							

TOTAL HOURS MIN.
RATE
AMOUNT

c

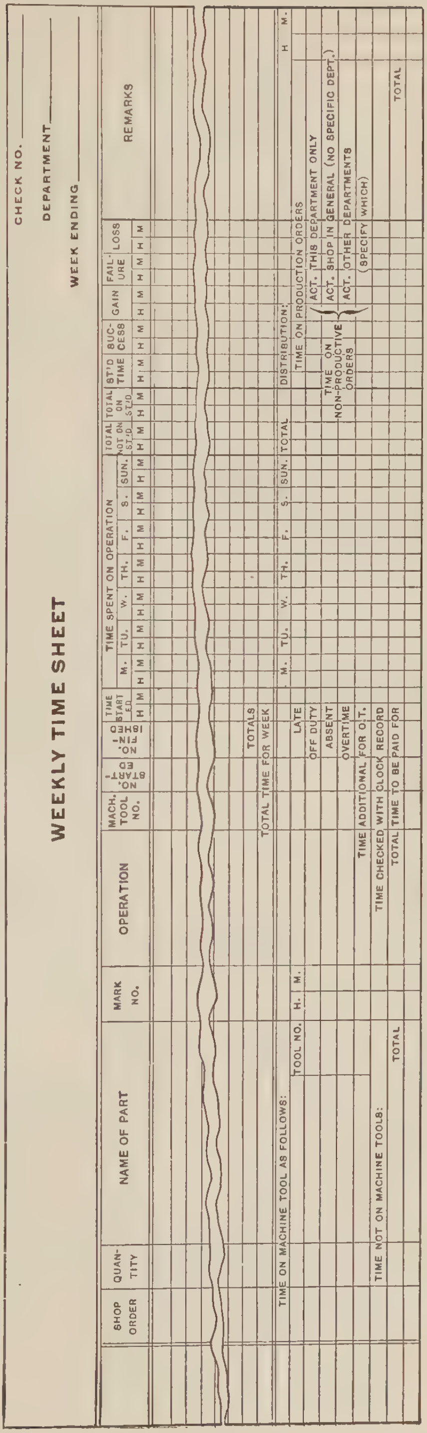
Fig. 136.—Individual operation clock card used as a job record. In this case the ticket shown in Fig. 107 serves only as a pay-roll basis. Manila cards, each 3 inches wide, 5 inches high.

In this system, as in all systems using time-stamps, it is necessary that the time-taker or the foreman be on the spot to stamp the clock card at the instant of changing jobs, in order that the time record may be accurate; otherwise the clock-stamping will have to be left to the workman himself, which is impracticable in cases of piece-work where a check on the workman's record is necessary.

277. Time-stamps.—Recently several kinds of secondary time-stamps, operated from a central Master Clock, have been put on the market, which provide for the workman stamping a job ticket near his tool or pressing a button making a record at a distance. These devices have been suggested as means for doing away with the delay necessitated by the man's hunting up the clock operator and waiting to get his job ticket stamped—a source of delay in most time-stamp systems.

As a general thing it is expensive and unreliable to have workmen post their own time for the purpose of making a record of the time spent on various jobs or orders. A mechanic will spend at least ten minutes a day on such time-posting, which will amount to one hour's time for each employee in a shop every week. For the same cost, a number of time-takers can be employed, one time-taker for every forty or fifty men, whose business it will be to take a record of all time on shop operations. A good Production or Planning Department will provide job cards already written out on which the only thing necessary to be inserted is the workman's number and the clock stamp.

278. Weekly Time-Sheet.—Fig. 137 shows a form of weekly time-sheet as used with a system where the time-taker records operations. This sheet is ruled up into columns headed as follows: "Shop Order Number," "Quantity,"



WEEKLY TIME SHEET

CHECK NO. ______
DEPARTMENT ______
WEEK ENDING ______

SHOP ORDER	QUANTITY	NAME OF PART	MARK NO.	OPERATION	MACH. TOOL NO.	NO. STARTED	NO. FINISHED	TIME STARTED	TIME SPENT ON OPERATION M.	TU.	W.	TH.	F.	S.	SUN.	TOTAL NOT ON STD.	TOTAL ON STD.	STD TIME	SUCCESS	GAIN	FAILURE	LOSS	REMARKS
								H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	

TOTALS
TOTAL TIME FOR WEEK
M. TU. W. TH. F. S. SUN. TOTAL
TIME ON MACHINE TOOL AS FOLLOWS: TOOL NO. H. M.
DISTRIBUTION: TIME ON PRODUCTION ORDERS H M
ACT. THIS DEPARTMENT ONLY
ACT. SHOP IN GENERAL (NO SPECIFIC DEPT.)
ACT. OTHER DEPARTMENTS (SPECIFY WHICH)
TIME ON NON-PRODUCTIVE ORDERS
LATE
OFF DUTY
ABSENT
OVERTIME
TIME ADDITIONAL FOR O.T.
TIME CHECKED WITH CLOCK RECORD
TIME NOT ON MACHINE TOOLS: TOTAL
TOTAL TIME TO BE PAID FOR
TOTAL

FIG. 137.—Form for weekly time-sheet. White bond paper, 16 inches wide, 9 1/2 inches high, ruled in blue, red, green, and purple.

"Name of Part," "Mark Number," "Operation," "Machine Tool Number," "Number Started," "Number Finished," "Time Started," "Time Spent on Operation." Then follow a number of columns which apply when a premium or bonus system is in vogue. These columns are headed as follows: "Total Time Not on Standard" (the word "Standard" in this case having the same meaning as premium or bonus system), "Total Time on Standard," "Standard Time," "Success," "Gain," "Failure," "Loss," and "Remarks."

The column headed "Time Started" is used to enter the time by the clock at which each operation is begun, the finishing time of one operation being the beginning time of the next. The next column, namely, the one headed "Time Spent on Operation," is sub-divided into seven sub-columns, one for each day of the week, provision being made for Sunday in case of emergency work. In these columns is entered the total time required for the operation. If an operation extends over more than one day, a horizontal addition along the line on which that operation is entered will give the total hours and minutes spent on that operation. This total is entered in the column headed "Total Not on Standard," if it is a job for which no standard time has been established. If it is a job on which there is an established time standard, the total is entered into the next column, namely, the one headed "Total on Standard." The following column gives the time allowance for the specified number of pieces. If the time in which the work was done was within the time standard, it is entered into the column headed "Success." If it was done in less time than the time standard, the amount by which it was less than the time standard is entered in the column headed "Gain." If the operation exceeded the time standard, it is entered in the column headed "Failure." The amount by which the time exceeded the time standard is entered in the column headed "Loss."

279. Instructions to Time-takers.—The following copy of instructions to time-takers will indicate how they are to do their work:

1. Do not take more of workman's time than is actually necessary to get the necessary information.

2. If workman is engaged in handling or setting up heavy work in his machine, do not call him away from same. See him at some later time.

3. The following questions should suffice to secure all information needed for time-taking:

"When did you start this job?"

"How many pieces did you finish on the previous job?"

"Where is the tag for your present job?"

"Name of operation on job engaged on?"

4. Always bear in mind that the starting time on one job is the stopping time of the previous job. Make no allowance for time spent in setting up machine.

5. In cases where workmen have no tag for job worked on, notify department foreman, and in case he does not provide a tag, notify shop tracer.

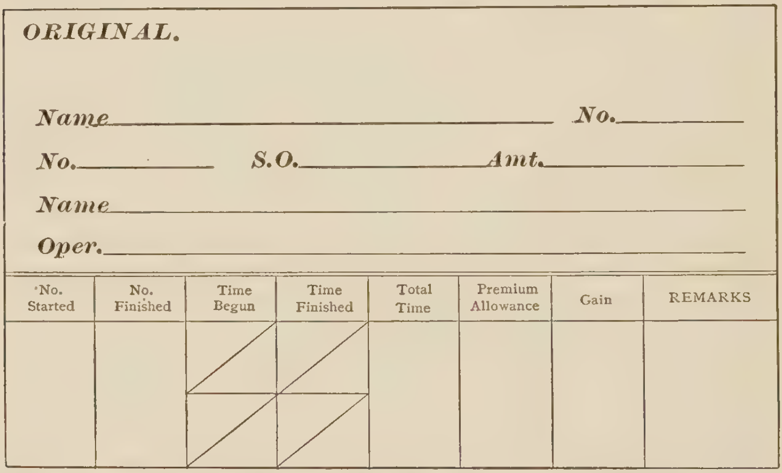
6. Instruct workman to hang tag for job on which he is working in some convenient place for you to see same. In passing about, look at both his tag and his work, so as to make sure he has not changed jobs. Familiarize yourself with the work going on through the department to which you are assigned, as that is a great aid to accurate time-taking.

7. The following information must be correctly given as called for on the time-sheet, *i.e.*, shop order, amount of pieces in lot called for by tag, name and number of part, name of operation or operations, number of pieces started, number of pieces finished, time started, time finished. Insist upon men reporting correctly the number of pieces finished whenever a break in a lot occurs.

8. You can be of some aid to the foreman in your department by informing him in advance that a man is likely to be out of a job at a certain time. It will be well to notify foreman about thirty minutes previous to the time a man will finish the job he is working on. This will give him a chance to look up the man's next job.

9. All time for jobs on which there is no regular shop order is covered by a list of standing orders. You must govern yourself according to this list in charging such time. Be sure to specify fully the nature of any such work; when there is any doubt as to what standing order number to charge this work to, consult head of cost department.

The weekly time-sheet as described possesses the advantage of easy checking against time totals independently taken from the clock cards. It also facilitates the posting by weeks on to cost sheets, and makes it possible to add up the entries for a given week against all of the shop orders, and making a sum total of these entries to check them against the week's pay-roll. In the lower left-hand corner of the time-sheet, as shown, is a summary of time on machine tools with the total hours done on each separate machine tool separately reported. This summary makes it easy to total up the total working hours of each machine tool, information which is needed where it is desired to establish an hourly machine rate for each machine. In the center of the sheet, at the bottom, is a summary covering attendances and overtime work, in which summary are listed for each



ORIGINAL.

Name ______________________ *No.* __________

No. __________ *S.O.* ______________ *Amt.* ______________

Name ______________________________________

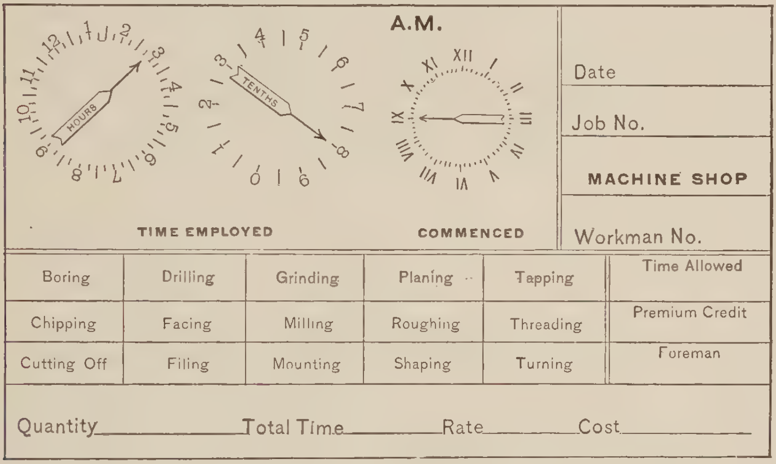
Oper. ______________________________________

No. Started	No. Finished	Time Begun	Time Finished	Total Time	Premium Allowance	Gain	REMARKS

FIG. 138.—Individual operation slip filled by time-taker. White paper, 6 inches wide, 3 1/2 inches high, perforated at lower edge, where it is attached to duplicate filled at same writing by inserting piece of carbon paper and folding back.

day: "Time Late or Off Duty," "Absent," "Overtime," "Additional time paid for on account of overtime," a check mark showing that the time was checked with the clock record, and the total time to be paid for for each day. In the extreme right-hand lower corner is a distribution showing the relative time spent on productive orders and on non-productive orders, the non-productive time being again subdivided so as to show whether non-productive time was put in in the department in which the man was listed, how much non-productive time was on account of other departments, such departments being specified, and how much non-productive time was for account of the shop in general. This summary is for the purpose of facilitating the establishment of a local hourly expense rate of operating, being independent of a further rate based on fixed charges; these fixed charges including such items as interest, insurance, etc.

280. Individual Operation Time-slips.—Another method of time report in which a separate time slip or card is written out every time a man changes operations is shown in Fig. 138. The example shown is written in duplicate by the time-taker, who hands one copy to the workman; the latter being in this way provided with a means for checking his gains under the premium system. In the example shown the time-takers write in the time.


HOURS
TENTHS
A.M.
XII
III
VI
IX

TIME EMPLOYED

COMMENCED

Date

Job No.

MACHINE SHOP

Workman No.

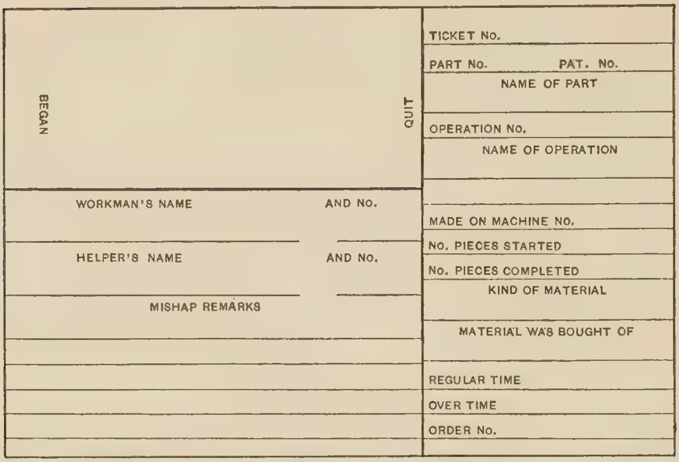
Boring	Drilling	Grinding	Planing	Tapping	Time Allowed
Chipping	Facing	Milling	Roughing	Threading	Premium Credit
Cutting Off	Filing	Mounting	Shaping	Turning	Foreman

Quantity__________ Total Time________ Rate________ Cost________

FIG. 139.—Calculagraph individual operation ticket. White card, 5 inches wide, 3 inches high.

These slips are sometimes bound in booklets of fifty or more, the booklet being intended to last a week. The front cover of the booklet serves as a time-card for registering starting and stopping time. The individual pages represent job tickets, and are torn out daily as filled and filed by job or order numbers. The back cover serves as a distribution of labor into productive, non-productive work on machines, work not on machines, etc.

281. Time-slips for Clock Stamping.—Fig. 139 shows a somewhat similar form in which the time-taker uses a calculagraph for stamping the time begun and time consumed. When the man is assigned a job, the time-card is written out and the first calculagraph impression is stamped on the card. As soon as the



BEGAN

QUIT

TICKET NO.

PART NO. PAT. NO.

NAME OF PART

OPERATION NO.

NAME OF OPERATION

WORKMAN'S NAME AND NO.

MADE ON MACHINE NO.

HELPER'S NAME AND NO.

NO. PIECES STARTED

NO. PIECES COMPLETED

KIND OF MATERIAL

MISHAP REMARKS

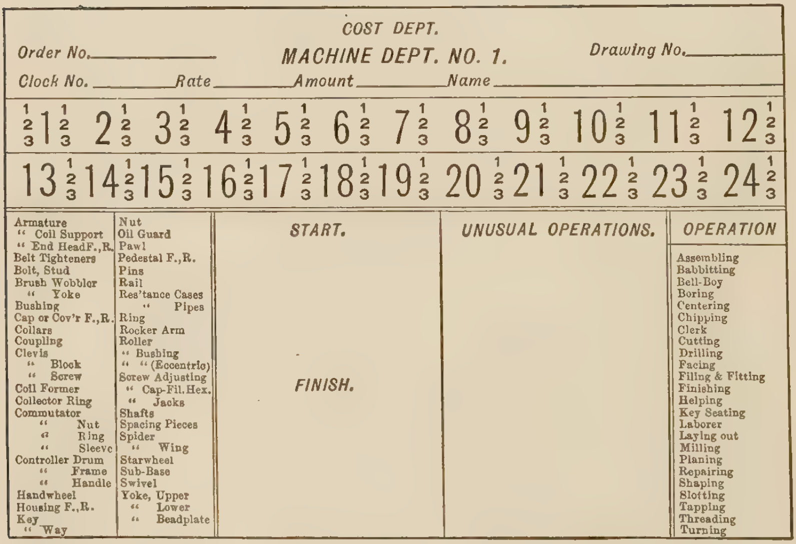
MATERIAL WAS BOUGHT OF

REGULAR TIME

OVER TIME

ORDER NO.

FIG. 140.—Time-card for use with time-stamp. Yellow card, 6 inches wide, 4 inches high.



COST DEPT.

Order No. ________ *MACHINE DEPT. NO. 1.* *Drawing No.* ________

Clock No. ______ *Rate* ______ *Amount* ______ *Name* ________

1 2 3	1	1 2 3	2	1 2 3	3	1 2 3	4	1 2 3	5	1 2 3	6	1 2 3	7	1 2 3	8	1 2 3	9	1 2 3	10	1 2 3	11	1 2 3	12	1 2 3
	13	1 2 3	14	1 2 3	15	1 2 3	16	1 2 3	17	1 2 3	18	1 2 3	19	1 2 3	20	1 2 3	21	1 2 3	22	1 2 3	23	1 2 3	24	1 2 3

Armature
" Coil Support
" End HeadF.,R.
Belt Tighteners
Bolt, Stud
Brush Wobbler
" Yoke
Bushing
Cap or Cov'r F.,R.
Collars
Coupling
Clevis
" Block
" Screw
Coil Former
Collector Ring
Commutator
" Nut
" Ring
" Sleeve
Controller Drum
" Frame
" Handle
Handwheel
Housing F.,R.
Key
" Way

Nut
Oil Guard
Pawl
Pedestal F.,R.
Pins
Rail
Res'tance Cases
" Pipes
Ring
Rocker Arm
Roller
" Bushing
" " (Eccentric)
Screw Adjusting
" Cap-Fil. Hex.
" Jacks
Shafts
Spacing Pieces
Spider
" Wing
Starwheel
Sub-Base
Swivel
Yoke, Upper
" Lower
" Beadplate

START.

FINISH.

UNUSUAL OPERATIONS.

OPERATION

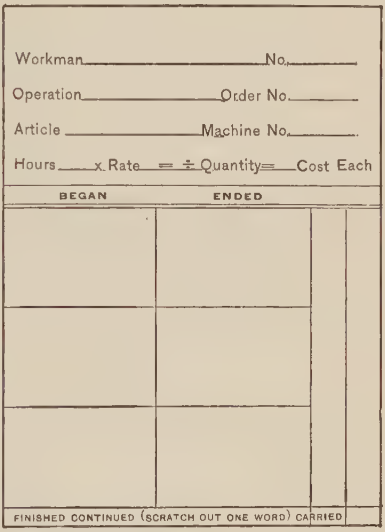
Assembling
Babbitting
Bell-Boy
Boring
Centering
Chipping
Clerk
Cutting
Drilling
Facing
Filing & Fitting
Finishing
Helping
Key Seating
Laborer
Laying out
Milling
Planing
Repairing
Shaping
Slotting
Tapping
Threading
Turning

FIG. 141.—Time slip having principal parts and principal operations in any department printed. (For use with clock stamp.) Blue paper, 6 inches wide, 4 inches high.

man has completed the job the time-taker stamps the second impression on the card, the second impression showing the time consumed. In order to use a calculagraph or clock stamp, it is necessary that the time-taker be on the spot all the time. This system always requires some of the workman's time to be spent in taking his card to the time-clock. Fig. 140 shows a similar form for use with a time-stamp.

282. Time-slip with Ordinary Operations Printed On.—Fig. 141 shows a time-slip in which the ordinary operations are printed in the extreme right-hand margin, with the name of the commoner parts on which work is done, in the extreme left-hand columns, a blank column being provided for entering in writing unusual operations, and further blanks being provided for clock stamps showing time of starting and time of finishing.

A still further form for use with the clock stamp or calculagraph is shown in Fig. 142.



Workman ____ No. ____

Operation ____ Order No. ____

Article ____ Machine No. ____

Hours ____ x Rate ____ = ÷ Quantity = ____ Cost Each

BEGAN ENDED

FINISHED CONTINUED (SCRATCH OUT ONE WORD) CARRIED

Fig. 142.—Another calculagraph form. White card, 4 inches wide, 5 1/2 inches high.

283. Tabulating Machine Systems.—Within the last few years the tabulating machine has come into use to some extent in connection with keeping account of workmen's time. In order to use a working card in the tabulating machine it is necessary to designate everything numerically, the record being formed by punching the digits in columns of figures printed on the card, such punching being done by a special machine. The punching may be done as a transference of records taken originally in pencil. The parts are designated by numbers, operations are designated by numbers; departments, machines, order number, the time, and the amount in dollars and cents to which the time is equivalent are all punched in the ticket. The tickets for a given day are put into a sorting machine which will classify them according to the same numbers in any column; for instance, all tickets may be assorted by departments, by operations, by men, by order numbers, etc., depending upon which column is being used for the purpose of assorting. After the assorting process has been finished, which is done at a very rapid rate by the machine, the cards are put into the accumulating or adding machine, which adds up the hours and minutes and dollars and cents total for any package of tickets.

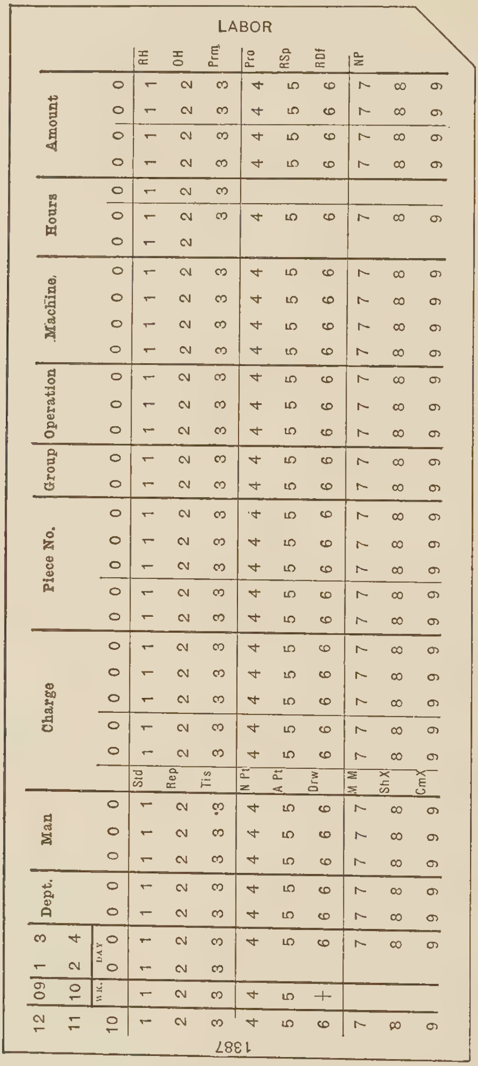
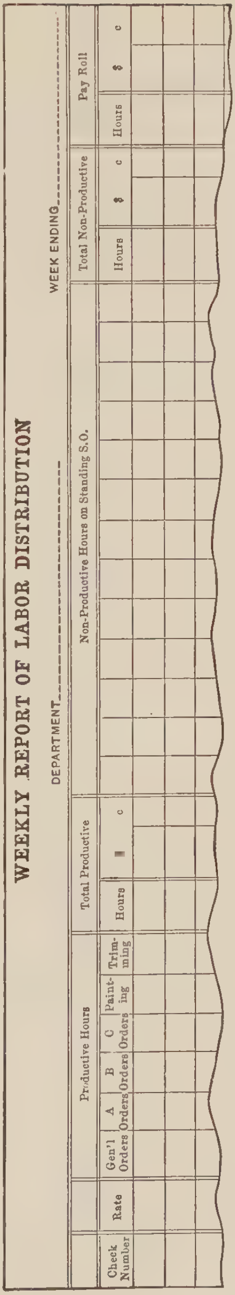


FIG. 143.—Workman's time report for use in tabulating machine. Manila card, 3 1/4 inches wide, 7 3/8 inches high.

Fig. 143 shows a card as used with a tabulating machine system as above described. The tabulating machine method makes it possible to post time and wages much more rapidly than any other method.

284. Pay-roll Distribution and Localization of Departmental Expenses.—In order to localize operating expenses by departments and to individual workmen, it is necessary to have some form of pay-roll distribution. A form for recording such distribution is shown in Fig. 144. A sheet of this sort is written out for each shop department. Opposite each employee, designated by his check number, is given his rate of pay, his time on each class of productive orders or direct labor. Then follows a summation of his total productive hours and the money value of his productive time. After this follow thirteen columns for non-productive standing orders. Although a factory may have about a hundred different standing orders to which non-productive work, operating expense, indirect labor, etc., may be charged, it is likely that thirteen columns will suffice for the different orders in any one department to which time will be charged in any one pay-roll period. After the detailed distribution of non-productive time follows a summation of the entire non-productive time of each employee and its cost in dollars and cents. The last column represents the total pay envelope of each employee.



WEEKLY REPORT OF LABOR DISTRIBUTION

DEPARTMENT__________ WEEK ENDING__________

		Productive Hours						Total Productive			Non-Productive Hours on Standing S.O.													Total Non-Productive			Pay Roll		
Check Number	Rate	Gen'l Orders	A Orders	B Orders	C Orders	Painting	Trimming	Hours	$	c														Hours	$	c	Hours	$	c

Fig. 144.—Labor distribution showing direct and indirect labor for each man in a department. White bond paper, 11 3/4 inches wide, 9 1/2 inches high, ruled in red and blue.

This sheet, made out for each department, serves as the basis for departmental summaries, showing local departmental expenses, affording at the same time complete data for analysis of the causes of these expenses.

CHAPTER XXII

COST DEPARTMENT

285. Competition and Costs.—The natural basis of selling prices is the shop cost. Competitors' prices must be considered, it is true; but no matter what these prices are, the shop cost must always be a positively known quantity.

The competitive system, by the necessity of meeting the prices set by rivals, has brought about pronounced economic advantages, when reductions in selling prices have followed similar reductions in cost through the introduction of labor-saving machinery or greater simplicity in design. On the other hand, many failures have resulted from blindly meeting prices set by others before actually reducing the shop costs of machines. This has been notably the case in the manufacture of electrical machinery. Some years ago the establishments manufacturing machines of large capacity for street railway power and municipal lighting plants demanded high prices for machines of low capacity. This opened the way for numerous small factories, which for some years were able to sell the small machines at prices considerably lower than the large corporations, and were able to prosper notwithstanding the admitted fact that the large corporations could not meet their prices on small machines without loss. In some cases, it is true, inferior machines were put on the market by the smaller establishments, but in many cases the lower-priced machines were efficient and well designed. The result was that the large corporations beset themselves to redesign their smaller machines, spending large sums in experiments for the purpose of obtaining cheaper insulating materials, for reducing the weight of the more expensive metals employed, and for winding and insulating coils by machine. The result was that some years later the large corporations were able to put on the market machines of lighter weight and more compactness than they had originally built, and, with improved methods of manufacture, were able to undersell the smaller manufacturers. Several of the small factories endeavored to meet the reduced prices, furnishing their heavy machines with expensive insulation and hand-windings, and were unable to stand the pressure. On the other hand, other small shops gradually worked up new designs and new methods until they were again in the field with machines practically identical with those of the large corporations, which they could afford to sell without loss, at competitive prices.

286. Importance of Cost Department.—It is apparent that during such transitional periods a well-conducted cost-keeping system is indispensable. No progressive shop can allow the figuring of costs to drag for months behind actual operations. It is necessary to know costs accurately and immediately. If the work of cost-keeping is turned over to an underpaid and overworked clerk, who has to expend all of his vitality and energy in calculations of multiplication and addition, and has no time left for comprehensive comparisons, accurate and valuable cost statistics cannot be obtained. The cost department work is of such importance in a factory that it should receive the attention of the very best intellect obtainable. This fact has been recognized by one of the largest American electrical corporations the present general manager of which is a man who some years ago had charge of the cost department. And here it will be well to consider the advantage of departmental organization of clerical and accounting work, as well as of the factory proper. The head of the cost department and the purchasing agent will be hampered in many ways if they are made subordinate to a bookkeeper or superintendent, as is the case in many shops. A departmental separation has been found to be productive of far more accuracy, since the heads of the various departments will feel perfectly free to present matters just as they appear to them.

287. Duties and Qualifications of Head of Cost Department.—It is extremely important that the chief cost clerk or manager of cost department have time to think and to compare. In a small establishment he may be able to do a considerable amount of calculation work, such as extension of costs of material, but there are few machine-manufacturing establishments of any magnitude which would not find it a decided advantage to have available the comparative data that are obtainable if the whole time and energies of a man can be devoted to the work of intelligent arrangement and comparison of costs of individual pieces and entire machines.

288. Cost System Must be Adapted to Product.—Costs may be figured on the basis of cost per pound or unit of bulk, this cost being subdivided either by cost per department, cost per class of material, or cost per process. For continuous processes such as steel mills, rolling mills, cement mills, flour mills, linseed oil mills, etc., the above methods of calculating costs are the ones to use. On the other hand, in shops making an assembled product composed of many pieces, such as furniture or machinery, the cost system must seek to secure costs per individual order and per component part.

289. Development of a Cost System.—Generally the first cost system installed in a shop does not seek to secure costs of individual pieces nor to locate expenses by departments; the object is usually only to figure out the cost of labor and material spent on any given order. The next step toward individual costs is usually the obtaining of costs on groups of work—as, for instance, in an electrical machine, the next natural step will be to secure separately the cost of the armature and of the fields. Then the armature costs will want to be divided again into the cost of commutator, cost of core, and cost of coils. As the cost department develops it will usually be considered desirous to obtain the cost of the labor on each separate heading in the various shop departments. Thus we might have under the heading of Armature Core, the labor items, "*D*—$3.49," and "*A*—$2.20," meaning that the work of section *D*, or the punching department, amounted to $3.49, and the labor of section *A*, or the machine shop, amounted to $2.20.

Naturally the final development of a cost system is the figuring of the cost of each individual piece as well as of each operation on that piece. Most of the individual pieces will be built on separate stock orders, the manufacturing quantity being regulated so as to be not too small a number of pieces on the one hand, thus making the cost of getting ready, getting tools, blue-prints, setting up machine tools, etc., a relatively small item compared with the total cost of the lot. On the other hand, the number of pieces put through on any one stock order must not be so large as to interfere with the uniform flow of all component parts through the machine tools to the assembling and erecting departments. When a suitable number of individual parts costs have been secured, the cost columns in a bill of material are easily filled out by inserting the latest or most accurate individual piece cost opposite the various parts and listing the labor spent in assembling, erecting, testing, cleaning, boxing, etc. These items are usually listed in a summary at the close of the bill of material.

290. Merging Cost Records into Regular Double Entry Accounts of Accounting Department.—This subject is treated in Chapter V on Factory Accounts, in which the fundamental underlying philosophy of the subject is given. The following brief summary is here again given:

For the purpose of merging all cost records into the financial accounts, proceed in the following manner: Let A represent the value of all labor, material, and total of all expense percentages spent on work in process up to the beginning of the period. Let B represent the value of all material, labor, and expense percentages spent on work in process during the period. Let C represent the value of all material, labor, and percentages spent on orders completed during the period. Then $A+B-C$ represents the value of the work in process at the beginning of the next period.

"Work in Process" is Debtor to "Material," "Labor," and "Expense," respectively, to the extent of the totals charged to incompleted orders during the period on the individual cost sheets. These amounts can be collected from the cost sheets by means of an adding machine.

"Finished Product" or "Stock" is debtor to "Work in Process," to the extent of the sum total of all orders completed during the period.

The unclosed balance of the "Work in Process" account, represents the inventory value of the work in process.

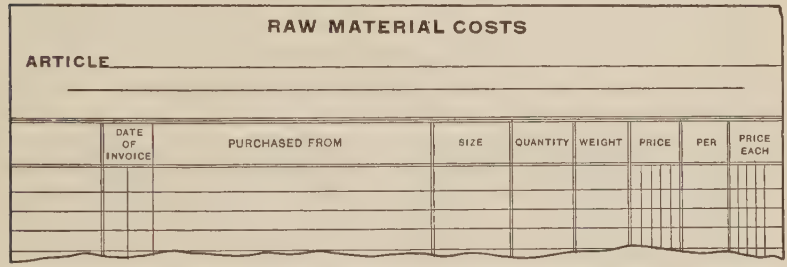
"Finished Product" or "Stock" is credited with the cost of all orders shipped during the period. The unclosed balance of the "Finished Product" account represents the inventory value of the finished product.

The unclosed balance of the "Material" account represents the inventory value of material, and if proper records of storeroom receipts and withdrawals are kept, the balance of this account should not vary by any wide percentage from the value obtained as the result of an actual inventory.

In case the general accounts carry the entire pay-roll in the "Labor" account, it may be necessary to have intercharges between "Labor" and "Expense."

The solution of the problem of merging the cost records into the general accounts is, however, not nearly as hard as is generally supposed. Using the above-suggested scheme as the basis for a working-plan, the problem can be worked out without any great difficulties, provided the head of the cost department and the head of the general bookkeeping department work with a determination to co-operate and appreciate each other's points of view.

291. Material Costs.—The basis for entries of material costs consists of the "orders on storeroom" or "withdrawal slips" or stubs on the tags accompanying the raw material into the shop, such stubs being receipted by the party getting the raw material, torn off by the man delivering the material, and by him turned into the stores department. The stores department, after making entries on the stores records, turns withdrawal slip or the stub over to the cost department.



RAW MATERIAL COSTS

ARTICLE

	DATE OF INVOICE	PURCHASED FROM	SIZE	QUANTITY	WEIGHT	PRICE	PER	PRICE EACH

FIG. 145.—Record of raw material costs. White bond paper, 9 1/2 inches wide, 12 inches high, ruled in red and blue.

Each of these withdrawal slips or order on stores or stubs of shop tag must bear the proper order number to which the material is to be charged, and all of them are preferably written out in advance of work being done, such writing out in advance being done in the Planning or Production Department.

These orders on stock are turned in daily to the stores clerks, and go from them to the cost department. The cost department files all these orders on stock and stubs of tags by order number, and when the order is completed they are taken out and compared with the bill of material if there was such a bill of material written for the order in question, and the cost of material figured.

292. Raw Material Costs.—Fig. 145 shows a form for keeping record of raw material costs. It is very important that the cost department keep an up-to-date record of raw material costs. A simple way of doing this is for the purchasing department to let the cost department have for a short time every day all invoices for materials. The cost department makes entries from these invoices in the form shown. This form, it will be noted, has vertical columns headed "Date of Invoice," "Purchased from," "Size," "Quantity," "Weight," "Price per," and "Price Each."

293. Costs of Manufactured Component Parts Made in Quantity on Stock Orders and Drawn from Storeroom.—In most shops the majority of the individual component parts are made up separately on stock production orders, and as a result, when a machine or contract order for which a bill of material has had to be made, is finished, the majority of component part costs can be taken as the cost per piece of the latest lot of components made in the shop. Component parts not made on stock order, but made on the bill-of-material order number, should have labor and material posted on individual component cards or sheets filed back of the guide card bearing the bill of material order number, thus providing individual component costs for the larger parts. Care must be taken in entering costs of parts manufactured in quantity and drawn from stores to see that the Burden or Expense Percentage or Rate is not added twice.

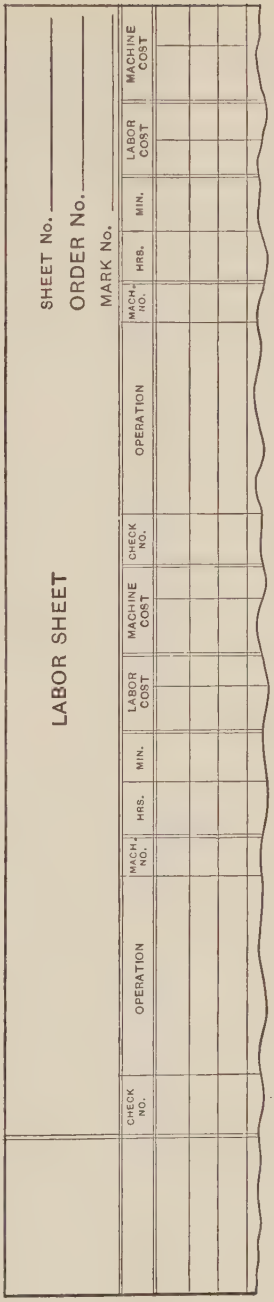
294. Current Value of Actual Invoice Price as Basis for Material Costs.—The question has sometimes been raised as to whether the material cost should be applied at the original purchase price of the material, at the prevailing market price, or at the average prices. If the chief object of the cost is to establish a selling price, then prevailing market price of material should be used. If the chief object of the cost is to balance all manufacturing accounts, then the original purchase prices of the material should be used.

295. "Material Burden."—Some cost accountants prefer to segregate from General Expense all items connected with cost of purchasing, receiving, handling stores and stores accounting, lumping these items together with Freight and Express and Drayage on incoming goods, to make a total Material Burden or Percentage on Material to be added to flat material costs in figuring total costs.

296. Labor or Time Postings on Cost Records.—Postings are usually made from the workmen's time-tickets or the weekly time-sheet on to labor sheets, similar to Fig. 146. In the upper right-hand corner of this form are spaces for entering the sheet number, order number, and mark number. There should be a separate labor sheet for each piece bearing a different mark number. The sheet bears vertical columns headed: "Check Number," "Operation," "Machine Number," "Hours," "Minutes," "Labor Cost," and "Machine Cost." As soon as all the labor done during any one week has been posted on the labor sheets, the total labor cost for each week is added and inserted on each sheet. The total on each sheet is then listed on an adding machine and checked against the total pay-roll. This necessitates the adding of all indirect labor charged to standing orders to the direct labor charged to specific production orders.

Where individual job or operation slips are used they may be conveniently filed in envelopes of standard card-index size, which are kept in card-index drawers. The envelopes may have a summary of cost printed on the face.

Where a weekly time-sheet is used the extension in dollars and cents of the time spent on the various operations and various orders can be adjusted so that the total dollars and cents are the same as the men's weekly pay envelope. Such an adjustment must be provided for where separate slips or cards are used for each change of job, or where costs are extended into dollars and cents from daily time-cards. In the latter cases, owing to the difference of extensions on account of figuring and carrying



LABOR SHEET

SHEET No.

ORDER No.

MARK No.

CHECK NO.	OPERATION	MACH. NO.	HRS.	MIN.	LABOR COST	MACHINE COST	CHECK NO.	OPERATION	MACH. NO.	HRS.	MIN.	LABOR COST	MACHINE COST

FIG. 146.—Form for recording labor on each component of each order. Labor added weekly and totals of all postings checked against pay-roll. White bond paper, 11 inches wide, 8 1/2 inches high, ruled in red, blue, green, and purple.

fractional cents, there is always some discrepancy between the payroll total of dollars and cents, and the cost clerk's distribution of dollars and cents which will have to be adjusted.

The time-posting clerks should be provided with a card-index record of employees' names, arranged numerically in consecutive order of check numbers. On each card is given the man's name, the date of starting, and his hourly rate. When the man quits, this is noted on the card, and if another man is assigned this check-number, entry is made on the same card of the new man's name, his rate, and the date of starting.

297. Checking Labor Postings against Pay-roll.—It is entirely feasible to check the labor cost postings as made against various orders, against the weekly pay-roll, thus assuring that all labor paid for is posted against orders. Where a weekly time-sheet is used this process is facilitated.

298. "Non-productive" or "Indirect" Labor.—"Productive" or better, "Direct" labor is usually such labor as is directly spent in making a given article. All other labor which is of a general character, no matter how essential to production, but which cannot be definitely assigned to a given tangible piece, or the making of inventoriable tangible assets, is designated as "Non-productive" or "Indirect" labor. There are also many supply materials which are designated as "Indirect" or "Expense" materials.

299. "Standing Orders."—"Non-productive" or "Indirect" work is usually taken care of by a series of "standing" orders, which are closed monthly. A man assigned to so-called "non-productive" or "indirect" work is told to charge his time to Standing Order Number so and so. In addition to the regular standing orders which are closed monthly, it may be found desirable to issue special specific orders for non-productive work whose cost it is desirable to segregate. It is desirable to have a distinct series for this class of orders, so that they can be easily distinguished from the productive shop orders and included in the monthly total of non-productive work.

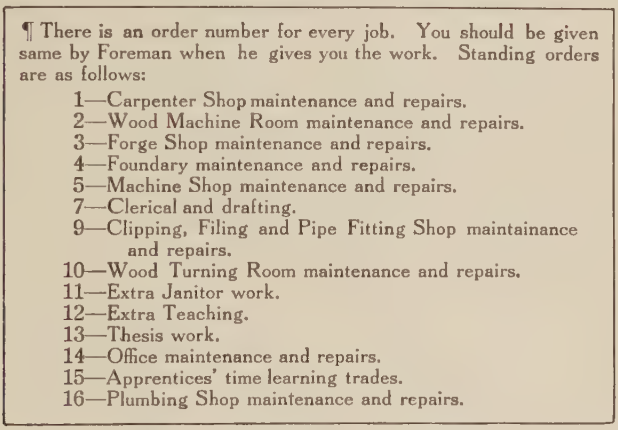
300. Plant Additions, New Equipment and Fixtures.—Items which instead of being maintenance expenses are manifestly improvements, should be built on a special order series so that they will be duly listed as assets instead of as manufacturing expense.

301. Typical List of "Standing Orders."—The following is a typical list of "Standing Orders":

Standing Order No. 1—Repairs to Tools.
Standing Order No. 2—Repairs to Shafting and Belting.
Standing Order No. 3—Repairs to Lighting Equipment.
Standing Order No. 4—Repairs to Patterns.
Standing Order No. 5—Cleaning Shop or Tools.
Standing Order No. 6—Weighing or Handling Material.
Standing Order No. 7—Overseeing.

Fig. 147 is the reverse of a time-card as used in the shops of the Pennsylvania State College, showing the standing orders in use at that institution:

A uselessly detailed and complicated system of standing orders is frequently installed by consulting cost accountants. The best way to stop leaks is to prevent them by good management. Detailed cost accounting with hundreds of standing expense orders will not stop wastes.



¶ There is an order number for every job. You should be given same by Foreman when he gives you the work. Standing orders are as follows:

1—Carpenter Shop maintenance and repairs.
2—Wood Machine Room maintenance and repairs.
3—Forge Shop maintenance and repairs.
4—Foundary maintenance and repairs.
5—Machine Shop maintenance and repairs.
7—Clerical and drafting.
9—Clipping, Filing and Pipe Fitting Shop maintainance and repairs.
10—Wood Turning Room maintenance and repairs.
11—Extra Janitor work.
12—Extra Teaching.
13—Thesis work.
14—Office maintenance and repairs.
15—Apprentices' time learning trades.
16—Plumbing Shop maintenance and repairs.

Fig. 147.—List of standing non-productive orders printed on back of time slip. Yellow paper, 3 inches by 5 inches.

302. Items Constituting Expense Burden.—Manufacturing expense properly includes such items as expense of supervision, namely, salaries of foremen, salaries of draftsmen, salaries of men in time and cost departments, salaries of men in purchasing department, salaries of men in stores department, salaries of men in shipping department, salaries of all men in toolmaking and repairing department, salaries for engineers, firemen, truckers, elevator men, and packers. Wages of such help as carpenters and painters ought to be applied to specific shop orders, such shop orders being of the productive series or of the non-productive series. Manufacturing expense will include such items as rent, taxes, insurance, water, light, fuel, pattern material, and wages, packing material, patent costs, law costs, membership in societies, experimental work, and miscellaneous factory expense.

A committee on uniform cost accounting of the National Machine Tool Builders' Association made the following recommendations as to the placing of certain manufacturing expenses:

In the matter of freight, express, and drayage they recommend including these items in the manufacturing expense rather than adding them to material costs, preferring the plan of diffusing such costs. In the matter of factory supplies the question was raised about the purchase of supplies for each month. These should be charged directly to the expense for the month or on stores account. The committee recommended the adoption of an average for each month high enough and based on past experience. Under this plan such purchases could be charged to suspense, and each month an equitable amount could be credited off to expense. The safe plan is to charge the purchases direct to expense—except in certain cases where a large stock is purchased ahead.

In the matter of Factor of Safety, the committee recommended as follows: With the greatest possible care in details there will always be contingencies of one kind or another arising, and to insure against such unforeseen yet possible differences a Reserve Account is suggested. Each period a proper charge, possibly 2 per cent. should be made to manufacturing expense, based on the total of such manufacturing expense as it appears before the element of safety is applied. This is intended to take care of general wastage throughout the shop, material leakage, breakage of material in warehouses, obsolete castings, etc. This does not refer to castings spoiled in the shop. These are charged direct to shop order as an extra material item.

Under the heading of Interest, the committee considers it incumbent that an amount should be charged into the burden element of the cost of each month equal to a fair interest of the value of ground, buildings, and plant equipment, viz., 1/12 of say 5 per cent. We cannot commence to figure profit until this interest charge is first added to the cost. The manufacturer who does not own his buildings and ground will charge rent instead of interest on these values into his costs. As to the plant equipment, the mere fact that a manufacturer has this paid for does not relieve him of charging an interest on it into his costs, any more than if he had out interest-bearing notes given in payment for it, or an issue of interest-bearing stock to cover this plant equipment. If he never earns more than a fair interest on his total investment, then he is practically earning no profit by his business transactions, since he could get this interest on his money without going into business. Therefore this interest should be added into the cost before we put on the profit which should establish the selling price.

303. "Fixed Charges."—Those items of manufacturing expense which can be predetermined with accuracy for the ensuing year, and which do not change from month to month are frequently designated as "fixed charges." These charges include such expenses as interest on capital invested, depreciation, taxes, rentals, and insurance. The other items of manufacturing expense are sometimes designated as the variable charges.

304. "Percentage on Labor" Method of Apportioning Expense Burden.—This method is by far the most prevalent method of apportioning the expense burden. If the output and wages are practically the same year in and year out this method will not be far from right. If such is not the case, however, the results as to total costs should be compared with results given by other methods of apportioning expenses.

In determining the expense percentage to be added to the cost of labor as shown by the time records, the simplest process, and the one most generally used, is that of adding a uniform percentage to the cost of labor on all classes of work. Thus, if the entire expense account of a factory, including the cost of unproductive labor, interest, insurance, depreciation, etc., is to the cost of productive labor as 150 is to 100, then one and one-half times the cost of labor on any article built in the shops will be added to its cost as shown by the bill of material and time records, in order to obtain the total cost.

305. Use of Separate Expense Percentages for Different Departments.—The foregoing method, while simple, is objectionable because it does not differentiate articles in the manufacture of which the more inexpensive machines of a plant are employed, from articles involving the use of very expensive machinery. On the other hand, it adds a very great amount to the necessary clerical work if a definite percentage is determined for each tool, and added daily to the operator's time.

306. Expense Percentage Different for Different Kinds of Product.—A compromise between these two extremes will be found in the differentiating of the output of a shop into several groups, and, by carefully examining the purchase cost and expense of operation of the tools employed in the manufacture of each group, similarly differentiating the expense percentage, so that a different per cent. will be added to the flat cost of machines involving greater expense in their manufacture than to the group in which less expense is involved. Thus, let us suppose that the total annual cost of productive labor in a shop is $100,000, and that the total expense, including unproductive labor, interest, insurance, depreciation, etc., amounts to $150,000. We might determine the actual total cost of each machine now by adding one and one-half times the cost of labor as shown by the time records. But suppose we draw a line between the kinds of machines manufactured, putting all the larger and special machines in a group by themselves, and all ordinary small stock machines into another group, and find now that the labor on the large machines amounted to $50,000, and the expense item on the same machines amounted to $100,000, while in the case of the smaller machines the labor cost amounted to $50,000, and the expense item for this group was $50,000. It is evident that we would cover our total annual expense item if we added twice the cost of labor as shown by the time records in the case of the larger machines, and once the cost of labor for the smaller machines. It is evident that the addition of one and one-half times the cost of labor to all machines would have been misleading, inasmuch as it would have represented the costs of the smaller machines as being higher than they actually were, and would have shown the costs of the larger machines at too low a figure. The addition of the single percentage would be quite likely to lead the management to the fallacious conclusion that they were unable to build small machines at as low a cost as some of their competitors, who confined their efforts altogether to the smaller type, and might cause them to allow their efforts toward selling the smaller machines to flag, and thus lose a line of business which would be in reality profitable.

307. Hourly Expense Rates.—The progressive tendency nowadays is to charge, in the form of hourly rates, all factory operating expenses outside of productive labor. The following example will show why it is more accurate to charge operating expenses by the hour than as a flat percentage of the productive labor cost:

Suppose a piece of work takes a man 30 hours, and that this man is receiving 20 cents on hour; the flat labor cost of the work is $6. Suppose our operating expenses are 100 per cent. of our productive pay-roll expense, then we must add 100 per cent. of flat labor to cover expense, or $6, making the total actual cost of the work $12.

Suppose now we employ a more skilful man who does the work in 20 hours at 30 cents an hour; the flat labor cost will be $6 as before, and the 100 per cent. added would make the total manufacturer's cost $12.

If, however, we had divided out total annual expense by the total number of productive hours put in during the year, and had found that the hourly expense rate was 20 cents an hour, we would figure the above work as follows:

1. In the case of a man getting 20 cents an hour we would have:

Flat labor cost, 30 hours, at $0.20 or	$6.00
Operating expense, 30 hours, at $0.20 or	6.00
Total manufacturer's cost	$12.00

2. With the more skilful man we would have:

Flat labor cost, 20 hours, at $0.30 or	$6.00
Operating expense, 20 hours, at $0.20 or	4.00
Total manufacturer's cost	$10.00

It is evident that by using the hourly operating expense we show that the higher priced mechanic, who did the work in less time than the poorer mechanic, made the job cost $10, whereas the poorer mechanic, to whom we paid the same wage amount, made the job cost us $12, because he occupied the shop floor space and used the machinery, power, and tools a longer amount of time than the skilled man.

A great step toward accuracy is taken when a shop once establishes an hourly operating expense, such operating expense being based on a grand total of all items in the expense account, divided by the total productive hours taken from all the payrolls during the year.

308. Departmental Hourly Expense Rates or Local Burden Rates.—Naturally the next step toward more accurate cost-finding will be to establish a general hourly operating rate which applies to all departments in the factory, keeping out of this rate all expense items which are strictly local departmental expenses, and making out of these local departmental expenses distinct hourly rates, applying to certain departments only.

The establishment in this way of local burdens, as well as a general burden rate, will go far toward putting the expense of operating high-priced and heavy-power machinery where it belongs, instead of diffusing it on bench work and other work which ought not to carry the expense of the machinery at all.

309. Hourly Machine Rates.—This brings us to the next point in development of accurate cost-finding; namely, the establishing of an hourly rate for each separate machine, such rate being distinct from and in addition to the wage rate of the man.

A number of different considerations enter into the establishment of the hourly machine rate. Among these are the following: (1) the interest and depreciation on the purchase price of the machine; (2) the annual cost of repairing the machine and keeping it supplied with belts, lubricants, and cutting tools; (3) the floor space occupied by the machine and the stock lying about it; (4) the power consumed by the machine; (5) the number of men required to operate the machine.

With the previous year's expense accounts as a basis, an estimate is made of the total amount to be charged to the ownership, operation, and maintenance of all machines. Out of this grand total or budget each machine tool is given a certain definite allowance or allotment for the coming year. A card is then written out for each separate machine tool, and after determining approximately the number of hours that the machine will run during the year, its hourly operating rate is established by dividing the total budget by the estimated total hours that the machine will run. Every time that the machine is used it is credited with its hourly rate, the amounts being posted on the card record for that machine tool from the cost department's records, showing amount of time machine has been used. If at the end of a quarterly or semi-annual period it is found likely that the postings on any card will over-run or fall short of the amount allotted the given machine, such changes in various machine rates as are manifestly equitable and necessary should be made.

A good deal of confusing and unnecessary detail has been gone into by several writers on cost accounting in describing hypothetical methods of incorrectly figuring machine rates on the basis that the machine rate included all of the factory expenses and was the only expense burden added. The machine rate has been in use many years before these writers were born, and has been pretty accurately worked out independently of the other expense charges in such establishments as planing mills or job machine shops.

310. Machine Rate should always be Separate and Independent of Other Expenses not Connected with Ownership and Operation of Machines.—When the machine rate is used, it is always desirable to use a separate local departmental burden rate for all charges of a strictly local departmental nature and not connected with machine operation. In addition to the local departmental rate, there should be a general expense burden rate which includes all expenses non-local or general in their nature and not connected with either machine operation or departmental expenses.

311. Wide Variation in Costs in same Establishment shown by Applying the above Different Methods of Apportioning Expense Burden.—Popular fiction has fascinated the average reader by the statement that modern cost accounting is so refined that a fluctuation in the third decimal point marks the dividing line between profit and loss. How absurd such statements are can easily be demonstrated by applying the above-described various methods of computing the expense burden to the same flat labor and flat material costs.

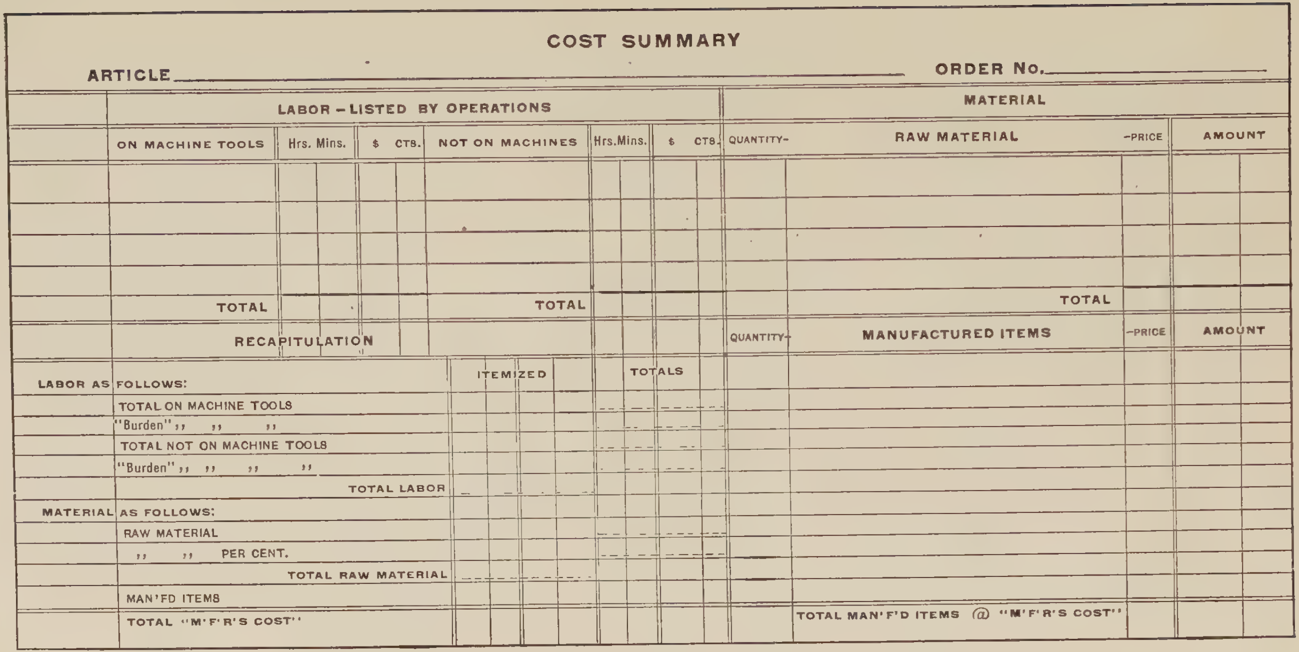
312. Importance of Manufacturers in Same Industry using Same Methods of Apportioning Expenses in their Cost Systems.—The machine tool builders, realizing the senseless competition that arises from ignorance of real costs, agreed to use a uniform system of apportioning expense burden. It would be well if other industries were to follow this example.

313. Co-operation between Accounting and Cost Departments.—In the matter of establishing the various burden rates or expense percentages, it is vitally essential that there be harmonious co-operation and mutual understanding between the chief accountant and the head of the cost department, a result which may require the exercise of great diplomacy for its accomplishment. It is necessary that the chief accountant recognize the desirability of local departmental expenses, and the segregation in the cost system of the portion of each department's pay-roll, which is indirect labor, as well as the material items chargeable to local departmental up-keep. He will also have to come to an understanding with the head of the cost department as to each month's shop production that constitute new assets in the way of standard drawings, standard patterns, standard machine tools, standard and special portable tools, office and shop fixtures, line shafting, and other plant additions.

The above matters are the most difficult to adjust and agree on, but if the chief accountant will approach the matter with a desire to understand and co-operate with the chief cost-keeper, and the chief cost-keeper will approach the matter in the same spirit, neither scoffing at the other's ignorance or stupidity, satisfactory agreement can and must be reached.

Having settled the portion of pay-roll and material which will have to go to local departmental indirect accounts, the next step is the agreement on what shall be the monthly factory burden. This burden consists of the indirect charges not chargeable to any one department, but chargeable to the shop as a whole, and includes such items as interest and deterioration, supervisional salaries, rent, machine depreciation, and power not included in hourly machine rates if the hourly machine rate prevails, and if it does not prevail, all rents, power charges, and machine depreciation; also light and heat, shop supplies, perishable and semi-perishable tools, defective workmanship, drayage and freight, boxing and crating, and other miscellaneous factory expenses already referred to.

In order to see whether the burden rate charged is sufficient to meet all the expense items, it is only necessary for the cost department to keep a large card on which are recorded the amounts of burden assigned to each order as completed, these amounts being totaled each month. If the totals fall below the accounting department's record to date since the beginning of the fiscal year, an advance in the rate will be necessary to secure a balance at the end of the year, and *vice versa*. Right here is where experienced cost accountants are likely to disagree with men whose experience has been confined to commercial bookkeeping as the latter are apt to call this burden rate adjustment "juggling" or "doctoring" of accounts. However, it appears to be the only way of securing a balancing of cost and stores records



COST SUMMARY

ARTICLE ______ ORDER No. ______

	LABOR – LISTED BY OPERATIONS						MATERIAL			
	ON MACHINE TOOLS	Hrs. Mins.	$ CTS.	NOT ON MACHINES	Hrs. Mins.	$ CTS.	QUANTITY–	RAW MATERIAL	–PRICE	AMOUNT
	TOTAL			TOTAL				TOTAL		
	RECAPITULATION						QUANTITY–	MANUFACTURED ITEMS	–PRICE	AMOUNT
LABOR AS	FOLLOWS:			ITEMIZED	TOTALS					
	TOTAL ON MACHINE TOOLS									
	"Burden" ,, ,, ,,									
	TOTAL NOT ON MACHINE TOOLS									
	"Burden" ,, ,, ,, ,,									
	TOTAL LABOR									
MATERIAL	AS FOLLOWS:									
	RAW MATERIAL									
	,, ,, PER CENT.									
	TOTAL RAW MATERIAL									
	MAN'FD ITEMS									
	TOTAL "M'F'R'S COST"							TOTAL MAN'F'D ITEMS @ "M'F'R'S COST"		

FIG. 148.—Cost summary. Buff bond paper, 11 inches wide, 8 1/2 inches high, ruled in red and blue.

with the commercial accounts that is consistent with a rational cost of conducting stores and cost records.

314. Notification of Completion of Orders.—The cost department should receive some systematic and prompt notice of the finishing of every shop order and every shipping order. The cost department is usually the final destination of the tracing tag which accompanies a lot of goods through the shop to the inspection department and storeroom, the tag going first to the stores record clerks, and from them to the cost department. Similarly, a copy of the packing list covering every shipping order, such list designating whether the shipment is partial or complete, goes first to the stores record clerks, and from them to the cost department.

315. Cost Summaries.—Whenever an order is closed in the cost department, the labor sheets covering such order are removed from the files and turned over to a cost-figuring clerk. He makes out a cost summary similar to Fig. 148.

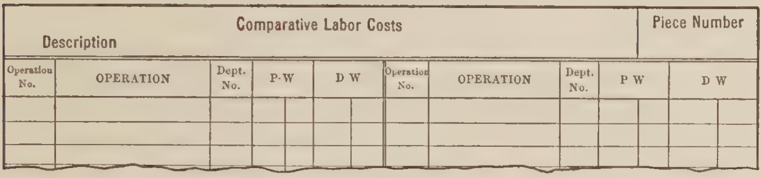
Drawing									Part No.	
Order No.	Date	Quantity	Labor	Material	Expense	Cost Ea.	Average Cost		Selling Price	

FIG. 149.—Comparative total cost record of individual parts. White card, 8 inches wide, 4 inches high.

This cost summary gives the name of the article and the order number. The labor, listed by operations, is divided into two classes, the first being labor on machine tools, the second labor not on machines. The labor report is listed on the left-hand side of the summary sheet, the right-hand side being reserved for a report of cost of raw materials and manufactured items. In the lower left-hand side there is a recapitulation giving the total labor on machine tools, total not on machine tools, and total burden or operating rate, also a summary of material, giving total of raw material, total per cent. added to actual cost of raw material, total cost of manufactured items, and total manufacturer's cost.

These summaries are briefly transcribed on to card records, one card for the billing department and one card for the cost department; such card records being filed by the number of the part. A form for this card is shown in Fig. 149. It bears columns headed "Order Number," "Date," "Quantity," "Labor," "Material," "Expense," "Cost Each," and "Average Cost."

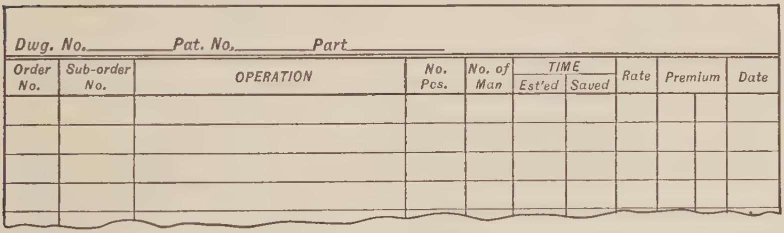
316. Comparative Individual Part Costs.—The foregoing card serves as a comparative cost record as well as a catalogue or price list of individual parts, and is useful in billing orders for supply parts or in inserting prices of individual parts when figuring cost of a total machine, as per individual items listed on the bill of material. An individual operation comparative cost card is shown in Fig. 150. Fig. 151 is arranged to contain a comparative cost of individual operations localized still further in that it reports the man doing the operation as well as his regular and premium wages on the operation.



Description			Comparative Labor Costs									Piece Number	
Operation No.	OPERATION	Dept. No.	P-W		D W		Operation No.	OPERATION	Dept. No.	P W		D W	

FIG. 150.—Comparative individual operation cost record. White card 7 3/8 inches wide, 5 inches high.

For all shipping orders the shipping department's order copy is sent to the billing department with the book previously referred to, in which book each order is receipted for. The billing clerk inserts on this order copy all selling prices which he has on record in the card index referred to. If there are any items on which he has not as yet costs, and consequently probably no selling prices, he confers with the cost department, who give especial attention to getting these prices figured immediately.

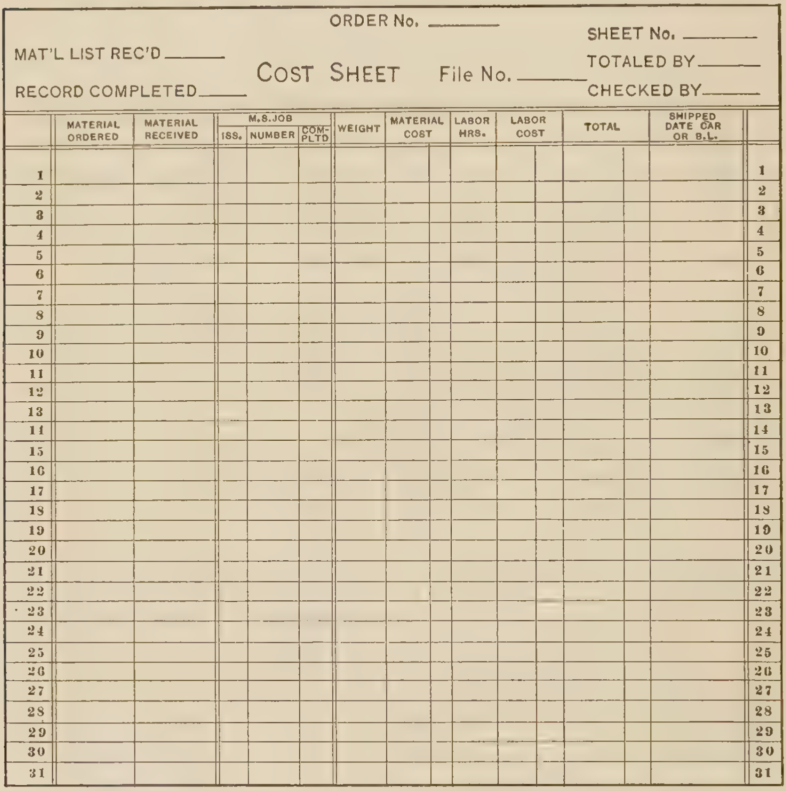


*Dwg. No.*________ *Pat. No.*________ *Part*________

Order No.	*Sub-order No.*	*OPERATION*	*No. Pcs.*	*No. of Man*	*TIME*		*Rate*	*Premium*		*Date*
					Est'd	*Saved*				

FIG. 151.—Comparative individual operation cost record giving data contained in form shown in Fig. 120, and specifying in addition the number of pieces made, the man performing the operation, his rate and premium. White card, 6 inches wide, 4 inches high.

317. Use of Bill of Material as Cost Record.—As previously stated, it is advisable to provide for bills of material separate insert cost sheets, so that the bill of material proper is not burdened with cost columns, which will be used in only one copy of the bill of material, whereas a number of copies of the bill will go to various shop departments to serve as a list of parts and assembling and erecting guide. Fig. 152 shows an example of insert cost sheet as used for reporting the individual component part costs on a bill of material. At the end of the bill will be reported the assembling, erecting, testing, painting, packing, etc., not chargeable to any individual component.



ORDER No. ______

SHEET No. ______

MAT'L LIST REC'D ______

COST SHEET

File No. ______

TOTALED BY ______

RECORD COMPLETED ______

CHECKED BY ______

	MATERIAL ORDERED	MATERIAL RECEIVED	M.S. JOB			WEIGHT	MATERIAL COST	LABOR HRS.	LABOR COST	TOTAL	SHIPPED DATE CAR OR B.L.	
			ISS.	NUMBER	COM-PLTD							
1												1
2												2
3												3
4												4
5												5
6												6
7												7
8												8
9												9
10												10
11												11
12												12
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28												28
29												29
30												30
31												31

Fig. 152.—Insert cost sheet for bill of material covering contracts or complete machine orders. White bond paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.

After all extensions of costs of material and of labor have been entered on the bill of material, it is turned over to the manager of the cost department. If the bill of material system has been carefully followed out, and all discrepancies in material attended to at once, as soon as they were made evident by the storeroom entries, there need be no delay in arriving at the total costs, the only operations necessary being the entering of labor costs and extensions of costs of material, so that complete cost bills can be had within a day, or at most two or three days, after completion of an order.

The complete bills of material with cost entries are conveniently filed in "document file cases," or in tariff files, a separate case being used for each order series, viz., the bills of material for "A" orders being filed in numerical succession by themselves; similarly the "B" orders, etc.

318. Comparative Complete Machine or Assembly Group Costs.—For quick reference to all machines of similar type and size, a card index should be kept, each card representing one certain type and size of machine, the order numbers being entered as machines of that particular size are completed. As there will be room on the cards for more than simply the order number, other brief entries may be made, which will frequently save reference to the complete bill. For instance, total weight, total cost capacity, and speed, might be entered on the same line after the order number.

Order No.	Complete	From Production Dept.	To Time Clerks	From Time Clerks	To Manager	Returned	Filed

FIG. 153.—Cost department's record of location of bill of material cost records. White paper, 7 1/2 inches wide, 10 inches high.

On receiving the complete cost bill, the cost clerk looks up several similar machines on his card index, and gets the bills covering these from the document files. A careful comparison, item by item, is now made with the new bill just turned in. Any discrepancies are investigated and accounted for, and a note giving the result of the investigation is attached to the bill of material, which is now sent to the general manager, being noted by him and returned again to the cost department to be filed away.

In order to prevent delays, and to enable any bill of material to be located at any time, little record books may be kept by the cost clerk—one book for each order series—in which are noted the dates on which the bills of material are received and turned over to the various departments or clerks, the books being ruled in accordance with Fig. 153.

319. Competitors' Prices.—Careful comparisons need to be made between the cost records of a shop and competitors' prices on complete machines and individual parts. The sales department should constantly be accumulating such data of competitors' prices from their bids. In all cases where it has been quite positively determined that prices have not been "cuts," and it is found that they are below what the shop can afford to quote, it is proper to investigate and see if some means cannot be found of meeting the competitors' prices. It is not a general rule that the members of a sales department are in position to ferret out for themselves the methods of meeting such competition. It is perfectly proper that the sales department should not confide its own selling prices nor those of its competitors to any other department of the shop. It is, however, of extreme importance that absolute truthfulness be observed in reporting to the technical departments the percentage by which a competitor has underbid the shop. A collection of competitors' prices may demonstrate that certain machines or lines of machines are costing the shop more than they ought to. It then becomes necessary to use every proper effort available to bring down the cost of the machine, and if the cost is cut down by legitimate means, an economic advantage has been gained not only for the shop, but, in a small way, for the trade at large. The constant reduction of prices of all manufactured commodities is by no means a sign of a demoralized condition of trade, but is a necessary essential to the world's progress. If this condition is met in a spirit of ill temper and haste, it is likely to result in business failure; but if it is taken hold of with intelligence and caution, it means success and prosperity to the manufacturer.

REFERENCES

Brisco: "Economics of Business," Chapter VI.
Gunn: "Costs" in Humphreys "Lecture Notes on Business Engineering."
Ennis: "Works Management," Chapter II.
Redfield: "The New Industrial Day," Chapters II, IV and V.
Evans: "Cost-keeping and Scientific Management," Chapters I–VII inclusive.

EMERSON: "Efficiency," Chapter VII.

GOING: "Principles of Industrial Engineering," Chapters V and VI.

CHURCH: "The Proper Distribution of Expense Burden."

CHURCH: "Production Factors in Cost Accounting and Works Management."

DAY: "Accounting Practice," Part II.

WEBNER: "Factory Costs," Chapters X–XXVII inclusive.

NICHOLSON: "Factory Organization and Costs," Chapters III and IV.

BUNNELL: "Cost-keeping for Manufacturing Plants."

CHAPTER XXIII

AIDS IN TAKING INVENTORY

320. Advantages of "Perpetual" Inventories.—In an establishment of sufficient magnitude to justify the employment of a full and capable clerical force to handle the records of the cost and stores department, stock-taking is not as formidable a matter as in smaller concerns. But in many large and prosperous manufacturing establishments the taking of an inventory is looked forward to as the most onerous task of the year. It is frequently months after the date on which the work of inventorying is begun before the final results are announced.

In factories where labor cost postings are balanced against the pay-roll, where stores withdrawals are expressed in money value as made, and where Raw Material, Work in Process, and Finished Product accounts are charged and credited as described in Chapters V and XXII, it is feasible to have the books closed and inventories taken as often as monthly. The question as to how extensive a factory must be in order to justify the employment of such a full clerical force is naturally one which depends upon the complexity of the manufacturing processes, and also upon the margin of profit. It is, however, true that the complete cost analysis revealed by a full clerical force may be in itself the very means of increasing the margin of profit. I had occasion to be shown the cost and stores system of a factory whose output amounted to about $250,000 of annual sales. The number of persons doing the clerical work in the establishment amounted to about 10 per cent., numerically, of the entire working force of the company, and it is fair to assume that their salaries represented at least an equal percentage of the total wages expenditure. At first I said this clerical force seemed disproportionately large, and yet I was assured by officials of the company that since the introduction of this system they were able to adjust their prices with a feeling of confidence that they had never before possessed. The books are closed, and a complete report of the company's business is rendered to the directors on the tenth of each month for all business done during the preceding month. The company has been able to meet the prices of all competitors and to maintain a high degree of mechanical excellence, and to declare exceptionally good dividends. The successful application of the complete cost and stores system to an establishment of this size, employing only about 100 men, has strengthened my conviction that the more general adoption of these methods in smaller factories will surely come, and will be accompanied by more general confidence and satisfaction on the part of both employers and employees.

There are, however, many factories that are not quite prepared to go so fully, or—as they would put it—plunge so deeply into shop-accounting systems, but with even an office force of minimum size the matter of inventory taking may be simplified by the use of properly arranged systems.

321. Classification of Items to be Inventoried.—In general the inventory may be divided into the following classes: (1) Plant; (2) Equipment; (3) Supplies; (4) Raw Materials; (5) Work in Process; (6) Finished Stock; (7) Obsolete Stock; (8) Defective, Second-hand, or Returned Goods.

The items coming under the head of "Plant," if properly recorded, can be inventoried in a very short time. Under this heading will be included real estate and buildings.

Under Equipment will be included such items as power-plant apparatus, transmission apparatus, piping, wiring, fixtures, machinery, patterns, drawings, special jigs, and special tools.

Under the heading of Supplies will come all such articles as do not enter into the product or if they do enter into it, cannot be definitely measured for a given part of the product, but which are incidental to the processes of manufacturing, such as files, sand-paper, emery cloth, machine oil, soda, belt dressing, etc.

Under Raw Materials will be listed all materials that enter into the manufactured product.

Work in Process includes all manufactured or partially manufactured parts which are found on shop floors or benches at the time of taking inventory.

Finished Stock includes all finished parts found in a finished parts warehouse. Also all finished groups of parts or complete articles ready for shipment found in the stock warehouse.

The other items are self-explanatory.

It is usually desirable to shut down the works at the close of business on a fixed date for the purpose of taking inventory, the works to remain shut down for as many days as experience has shown to be the minimum time to take inventory satisfactorily. It is always best to take the work in process first, so that in the event that the number of days provided for in advance may not prove sufficient, the checking of the completed stock and raw material will be left to the last, to be gotten hold of after the works have resumed operations, as this plan has caused the least inconvenience.

322. Tag System of Taking Annual Inventory.—It is desirable to provide a large number of consecutively numbered tags, these tags to be given out in bunches of 100 to 500 tags, in such numbers as may be required, to the parties in charge of the stock-taking on each floor or in each department of the works, and it will be the duty of these parties, after weighing or counting the stock, to securely fix these tags to every bin, box, or rack, or piece of material. These tags will be provided in different colors corresponding to the classes above outlined.

When all the stocks, after counting or weighing, will have been tagged in this way, checkers will collect the tags.

A record must be kept of all tags given out and to whom, and all tags, whether spoiled or used or not, must eventually be returned to the checkers.

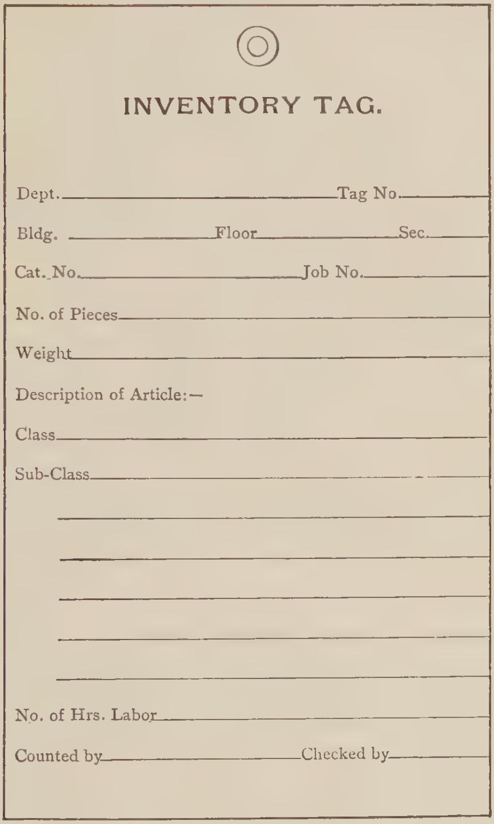
323. Checking Inventory.—The manner of taking the inventory must be most thorough in every respect, so that reliable results will be obtained; actual weight, quantity, or measure must be applied in every instance possible. The foreman of each department and a checker should superintend the weighing and counting of all material in that department, and will see that same is correctly entered on the inventory tag. Where weighing or counting is not practicable and estimates only can be obtained, the foreman and checker should agree upon the proper figure, and they should both put their initials on the tag, which should be marked "Estimate."

It rests with the foreman and checker to determine what materials can or cannot be estimated according to the existing conditions, and no set rule can be laid down. The purpose and intention should be to count or weigh everything possible.

As far as possible all material should be collected and piled up before taking inventory, with a view to facilitating a correct and expeditious count.

While the inventory is in progress no stock may be moved from one department to another.

324. Material in Transit.—If it is found after taking inventory that material was in transit for which invoices were rendered bearing date of shipment previous to date of inventory, such material will be included in the inventory. On the other hand, care must be taken that no goods are booked or billed as "Shipped Out" from the factory which are all ready to ship and then included as stock on hand. In may be necessary to ship goods on an order during the course of the inventory, but a note will be made of same and the item included in the final inventory properly annotated.



INVENTORY TAG.

Dept. Tag No.

Bldg. Floor Sec.

Cat. No. Job No.

No. of Pieces

Weight

Description of Article:—

Class

Sub-Class

No. of Hrs. Labor

Counted by Checked by

FIG. 154.—Form for inventory tag. Colored tag. Stock, 4 1/8 inches wide, 7 inches high.

325. Classification of Work in Process and Finished Product.—A further differentiation of work in process of manufacture and finished stock is usually desirable by classes of product. For instance, a concern manufacturing electrical mining machinery might have the following classifications: Class A, Chain Mining Machines; Class B, Locomotives; Class C, Generators; Class D, Long Wall Machines; Class E, Drills; Class F, Standard Motors; Class G, Switch Boards; Class H, Hoists, etc., etc.

The designation of the material according as it comes under one of these classes must be clearly designated on the tag. A form for such inventory tag is shown in Fig. 154.

326. Units of Measurement.—In recording raw material and supplies, care must be taken to see that the proper unit of measure is entered on the tag, in stating the quantities on hand, that is, the unit of measure by which the article is usually priced and sold, whether pounds, feet, dozen, etc.

327. Shop Order Numbers for Work in Process.—In reporting the work in process, it is important to give the shop order number as well as catalogue or part number, and to state clearly the condition of the order as to the value of labor and amount of material expended to date, such information being obtained usually from the cost department records. All parts found on the shop floor or benches must be considered as orders representing work in process, whether there appears to be any labor performed or not on the job.

Where the number of parts by actual count, found on an order in process, is different from the number called for by the order itself, the inventory should give the actual weight or unit of measure, and an estimate must be made as to the value of labor and material, such estimate possibly differing from the records in the cost department.

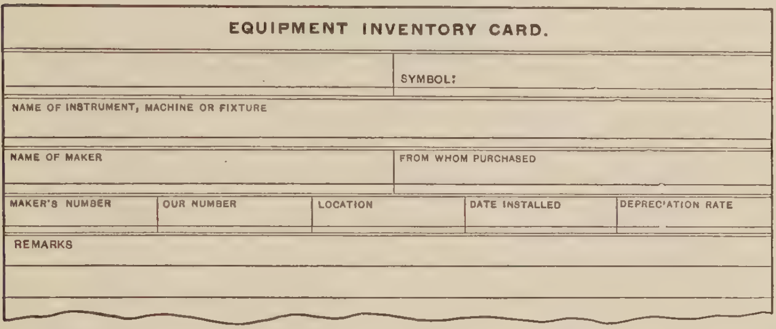
328. Depreciation on Obsolete Goods.—A percentage of depreciation must be agreed upon for obsolete or unsalable stock.

329. Collecting Inventory Tags.—The inventory having been taken, the tags will be collected by checkers and sorted in numerical order, to determine that none are missing, the last tag being clearly marked "Last Tag, Number . . . ."

The shop must be carefully divided into divisions, and men definitely assigned with checkers to each division.

330. Sold Goods.—Completed machinery, etc., that has been billed to customers, and that is being held subject to their orders, must be specially designated by a notation in red pencil or in some similar manner on the tag.

331. Classifying Materials.—For convenience in cataloging, it may be found desirable to classify all tags by class of material, the material when thus grouped or lumped being copied from the tags on to large sheets, the number of the tag being referred to in each entry on these sheets, and all tags after all entries are made being again rearranged in numerical order, each tag having been marked with some sign or stamp to designate that it had been entered on the inventory record.



EQUIPMENT INVENTORY CARD.

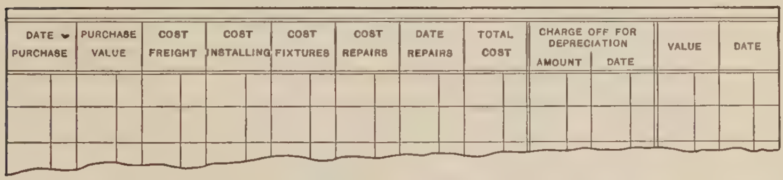
	SYMBOL:
NAME OF INSTRUMENT, MACHINE OR FIXTURE	
NAME OF MAKER	FROM WHOM PURCHASED

MAKER'S NUMBER	OUR NUMBER	LOCATION	DATE INSTALLED	DEPRECIATION RATE

REMARKS

FIG. 155.—Equipment inventory card. (Front.) White card, 6 inches wide, 4 inches high.

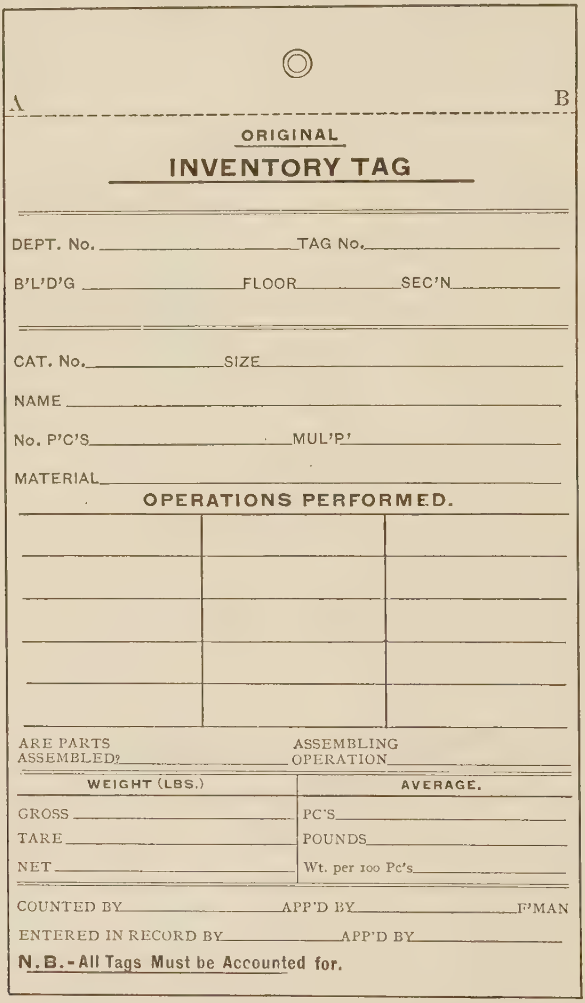
332. Equipment Inventory.—It is usually desirable to preserve a permanent card record covering equipment items, a distinct card being kept for each equipment item on which is recorded such description as "Symbol," "Maker," "From whom bought," "Date put in use," "Improvements or Repairs," as may be advisable. A form for such record is shown in Fig. 155, and the reverse of the form is shown in Fig. 156.



DATE PURCHASE	PURCHASE VALUE	COST FREIGHT	COST INSTALLING	COST FIXTURES	COST REPAIRS	DATE REPAIRS	TOTAL COST	CHARGE OFF FOR DEPRECIATION		VALUE	DATE
								AMOUNT	DATE		

FIG. 156.—Equipment inventory card, reverse. (See Fig. 126.) White card, 6 inches wide, 4 inches high, ruled in red and blue.

333. Depreciation and Repairs on Equipment.—On the reverse as shown are recorded cost of repairs or amount of annual depreciation, and the balance showing latest inventory value.



A B

ORIGINAL

INVENTORY TAG

DEPT. No. ________ TAG No. ________

B'L'D'G ________ FLOOR ________ SEC'N ________

CAT. No. ________ SIZE ________

NAME ________

No. P'C'S ________ MUL'P' ________

MATERIAL ________

OPERATIONS PERFORMED.

ARE PARTS ASSEMBLED? ________ ASSEMBLING OPERATION ________

WEIGHT (LBS.)	AVERAGE.
GROSS ________	PC'S ________
TARE ________	POUNDS ________
NET ________	Wt. per 100 Pc's ________

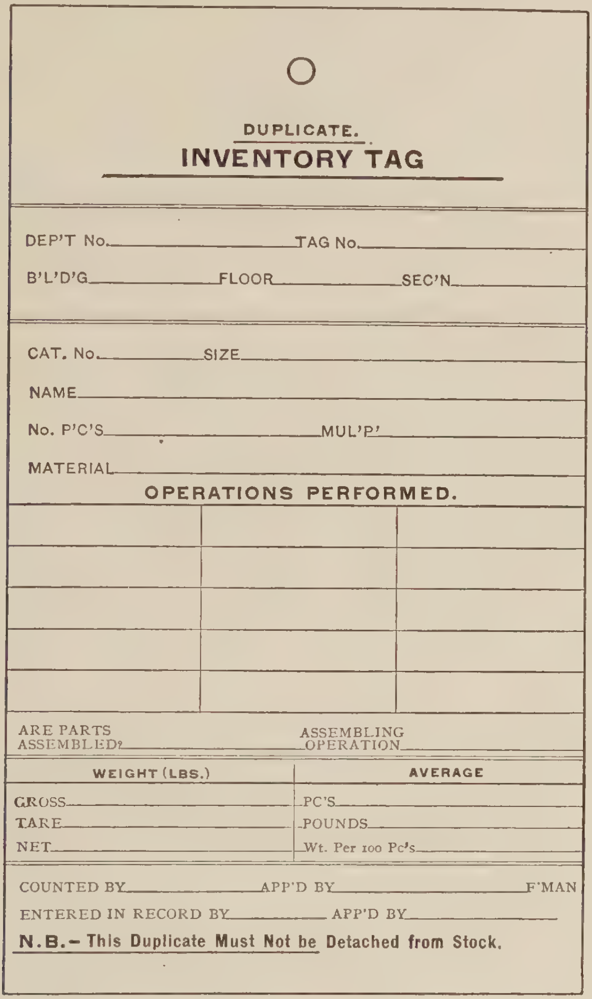
COUNTED BY ________ APP'D BY ________ F'MAN

ENTERED IN RECORD BY ________ APP'D BY ________

N. B.-All Tags Must be Accounted for.

Fig. 157.—"Original" or upper sheet of inventory tag. Fastened to "duplicate" tag shown in Fig. 158 by reinforced eyelet and perforated along line A–B. Original buff bond paper, 4 1/2 inches wide, 7 3/4 inches high.

334. Duplicate Inventory Tags.—Some appraisal companies use a tag with a perforated, removable, duplicate strip attached, writing the tags in duplicate with a piece of carbon, and removing the perforated strip immediately after writing out the tag.



DUPLICATE.

INVENTORY TAG

DEP'T No. TAG No.

B'L'D'G FLOOR SEC'N

CAT. No. SIZE

NAME

No. P'C'S MUL'P'

MATERIAL

OPERATIONS PERFORMED.

ARE PARTS ASSEMBLED? ASSEMBLING OPERATION

WEIGHT (LBS.)	AVERAGE
GROSS	PC'S
TARE	POUNDS
NET	Wt. Per 100 Pc's

COUNTED BY APP'D BY F'MAN

ENTERED IN RECORD BY APP'D BY

N.B.– This Duplicate Must Not be Detached from Stock.

FIG. 158.—"Duplicate" inventory tag. Fastened together with "original" by reinforced eyelet. (See Fig. 157.) Manila tag stock, 4 1/2 inches wide, 7 3/4 inches high.

This lessens the liability of errors due to lost tags. A form for such a tag is shown in Figs. 157 and 158.

335. Proper Percentage of Depreciation.—The proper percentage of depreciation to be used for various classes of equipment is a matter which has been discussed at length by various writers. Experiments have been made to determine the average life of various tools. It is evident, however, that the length of life and rapidity of deterioration of machinery and transmission parts will vary widely. Where trustworthy data based upon a number of years of observation are not at hand, it has been customary to allow a general depreciation of 10 per cent. per annum on all machines. On belting and transmission apparatus in general, a slightly larger depreciation is sometimes charged, varying according to the service. Buildings kept in good repair are often charged with a very low percentage of depreciation.

336. Inventorying Patterns and Drawings.—The real value of patterns and drawings as an asset is a matter over which there is considerable difference of opinion. Special patterns and drawings are charged to the particular order for which they are made, and then can be of no value except as scrap. On the other hand, standard patterns and drawings have a real value which should be subject to considerable depreciation. Where the value of standard drawings and patterns is not kept for each piece, but all work on such patterns and drawings is charged on a standing order number, the total cost of all new standard patterns and drawings for the year is given by a standing order, and this total added to the properly depreciated value of the standard patterns on hand at the close of the previous year will give the current value. This method, of course, does not assign a definite price to each individual pattern and drawing.

The valuing of goods is facilitated by the cost department having on hand lists of all standard materials with the prevalent net price reduced to a price per unit of measure or weight.

337. Perpetual Inventories to be Verified by Actual Count.—At the beginning of this discussion it was stated that the taking of an inventory is greatly facilitated by the keeping up of accurate stores records. It must not be assumed that the stores records may be taken as inventory values. All systems of mathematical record need to be checked annually by an actual count. Such actual count may be made the basis of just as thorough an inventory as could be taken by an outside appraisal company. In fact, where it is customary for the sake of furnishing what would appear to be absolutely unprejudiced and unbiased values by employing an outside appraisal company, the work of such appraisal company is made much easier and more accurate in establishments where inventories taken by the regular force of the company have been thorough and systematic.

338. "Replacement" Values.—In attaching values to factory fixtures, special tools and other items which are essential parts of the plant, it is customary to value them at what it would cost to replace them in their present condition, and to consider their worth on a basis of what value they would have to a company engaging in the same line of business on the same premises, and not the figures that articles would bring if sold at a forced sale.

339. Cost System as an Aid to Inventorying.—The accuracy of the inventory prices attached to finished and unfinished parts depends upon the cost-calculating system employed. If a company's cost records are known to be correctly kept, then the rational way to obtain the cost of unfinished parts would be to close up to inventory date all time and material records on all unfinished orders. With a cost system in which the costs of individual parts have been built up, recorded, and compared, these costs serve as the basis of accurate inventory valuation.

340. Congested and Disorderly Stock-rooms.—One of the greatest disadvantages from which inventory taking usually suffers is that due to extremely congested stock-rooms and stock floor. Another great disadvantage will be found in lack of promptness in identifying items on the shop floor and leaving them without identifying tags.

The mere issuing of instructions to foremen to see that floors and benches are cleaned up and stock neatly arranged is not sufficient; it may be necessary to hire special help to see that this work is actually carried out. Previous to inventory time as much useless material as possible should be scrapped.

The person in charge of each department and the checker for that department must, under no circumstances, let a piece pass by without tagging it, with the idea that they will look it up afterward.

341. Precautions Regarding Inventory Taking.—The following list of precautions will be found serviceable in connection with inventory taking:

At a period of time not later than two months previous to the date of the inventory, every bin and every class of article in every warehouse and stock-room must be labeled with its proper name and mark number, if there is any; pattern number, if there is any; also, where two units of measurement are required, such as number of feet and pounds, the label or tag must bear the weight per foot, or whatever the conditions require.

(1) The head stock-keeper will, at the time above indicated, check up each bin and item, and see that these labels are provided, so that the stock-taking can be done by any clerk copying the information on the bin labels or tags.

(2) A complete finding list must be provided by the head stock-keeper at this time. This finding list must catalogue all material, whether it is purchased finished stock, or whether it is stock manufactured by the company, such finding list giving, after each item, the number of the bin in which it is located. The preparation of such a finding list will prevent articles of the same class being stored in different bins.

(3) The shop foremen *must* get under benches and into pigeonholes and get out all unlabeled and unidentified material. The shop floor *must be cleared* of everything, except work in process. The personal co-operation of the shop disciplinary heads must be used to see that this is done. Unless vigorous steps are taken to enforce this clearing up, it will be extremely difficult to take stock accurately.

(4) The head of the cost department will receive the numbered inventory tags, and put them under lock and key. When he issues these tags he will take a written receipt from each person to whom he issues them. He will issue these in lots not to exceed 500 at one time.

(5) These inventory tags will have carbonized slips with the same printing on them as is on the face of the tag, stitched to the tag. These carbonized tags will be torn off as the tags are written up and kept on file by the person detaching the tags. This will secure a duplicate of the tag being on file, so that, in case any tag is lost, it will be known what was written thereon.

(6) At a period not later than one month previous to the figuring of the inventory, a complete price catalogue should be in readiness, such price catalogue containing the very latest prices of all raw material. This catalogue should list every item appearing in the last preceding inventory.

(7) The shop costs must be figured up to date on all completed and uncompleted orders, so that it will not be necessary to estimate the time spent on work in process.

(8) At a period not later than thirty days before stock-taking, every order which the records show to be a "live order" must be checked in the shop so that there is a certainty of its being in actual existence in the shop.

(9) In order to distribute the work of stock-taking in such a manner as not to over-burden any one department, the work should be allotted as follows: The head cost clerk will be in general charge of the inventory; the receiving department will take stock of all raw material; the stores department will take stock of all supplies and finished stock; and the cost department will take stock of all work in process.

(10) The men who wrote certain inventory tags will accompany the checkers who collect these tags; they will have their duplicates to assist them in accounting for any missing tags.

(11) Work in process should be figured from the cost department records. Articles on the shop floor nevertheless should be tagged and the tags collected just as soon as all items have been tagged and checked. This will permit of a check of the work in process, as shown by the tags, against the same as shown by the cost department records of uncompleted orders.

(12) All figuring of prices, weights, etc., should be done on the tags themselves. Also all arrangements of lists of stores, by sizes, etc., previous to any copying on the sheets, are to be the result of sorting of tags.

(13) The transcribing should be done very carefully in ink on the permanent record sheets, to be placed in a substantial binder. This will constitute the permanent inventory, and may be copied on the typewriter in manifold.

(14) The shop time-takers will be usually found the best assistants in the inventory of work in process.

REFERENCES

Parkhurst: "Applied Methods of Scientific Management," Chapter V.
Brisco: "Economics of Business," Chapter VIII.
Webner: "Factory Costs," § 235.

CHAPTER XXIV

INSPECTION METHODS IN MODERN MACHINE SHOPS

342. General Classification of Inspection.—The work of inspection naturally divides itself into two groups:

(a) That having to do with raw materials and purchased parts.

(b) Inspection having to do with manufactured product.

343. Inspection of Raw Materials and Purchased Items.—In order that raw material and purchased parts may be satisfactorily inspected, it is necessary that the purchaser's requirements be specifically set forth. This consideration demands the preparation of specifications. The preparation of such specifications for a given shop is a matter which requires a careful investigation of past experiences. The person writing such specifications should consult all possible sources of information as to what has been past experience with respect to troubles and difficulties in connection with any given material or part. This is necessary in order that the specifications may be not only correct from a theoretical standpoint, but in order that they may be practical as well. A draftsman, foreman, or a salesman may be able to give useful information in connection with the preparation of specifications for purchased material.

If the establishment is large enough to have a testing laboratory of its own, such a laboratory will prepare these specifications in conjunction with the various engineers of the company.

In the inspection of raw material we have to cover two general features:

(1) Quality as depending on composition.

(2) Quality as to dimensions.

Inspection as to composition may come under three classes of requirements:

(1) Physical.

(2) Chemical.

(3) Magnetic or electric.

Inspection as to dimensions and form would apply more particularly to castings or finished parts which must coincide with drawings or other specifications.

Raw material purchased in large quantities may sometimes be best inspected, as to composition and manufacture, at the plant of the maker, so far as physical qualities are concerned.

Chemical, magnetic, or electric qualities are best tested in a laboratory which may be part of the organization of the company making the specifications, or it may be done in a commercial laboratory conducting testing for outside clients.

Such articles as bar, sheet, and other stock may be inspected in the receiving department as to quality, size, shape, and general appearance of material. This class of inspection, although usually conducted by non-technical help, is about all that can be done with regard to materials received in small quantity, as the cost of technical inspection would be too high.

344. Inspection of Manufactured Product.—The inspection of manufactured product divides itself up into:

(1) Dimensional inspection during the course of manufacture.
(2) Inspection of groups of parts.
(3) Erection inspection.
(4) Electric or magnetic inspection and testing.
(5) Final inspection and testing of complete machines.

345. Dimensional Inspection.—Some few American shops make a dimensional inspection after every machine-shop operation. Where this is the practice it is necessary to have a representative of the inspection department visit every leading factory department at regular intervals. The record of the inspection is made by having the inspector write his name or initials after the operation which the inspection covers, as listed on the routing tag accompanying the pieces during their process of manufacture. In some shops the inspector accompanies the "move material men," motor trucks being used.

In many shops, however, it is not necessary to conduct a dimensional inspection after every operation, nor, indeed, is it necessary to inspect all parts. In many cases it will be satisfactory if only such parts as are subject to renewal are inspected when all machine-shop operations are finished. Such parts may be designated by the engineering department on the bill of material. As the routing or tracing tag is usually copied from the bill of material the tag will call attention to the required inspection.

346. Floor Inspection.—In addition to the floor inspection of such pieces as require inspection during process of manufacture, this requirement being designated on the bill of material and shop routing tag, as indicated, it is advisable that all manufactured parts, before going into a permanent stock-room of finished parts, or into a temporary stock, from which they may be drawn for assembling or erecting purposes, should pass through an inspection department which will check the parts with the blueprints with such degree of accuracy as the judgment of the head inspector will dictate.

347. Verification of Inspection.—Small articles made in quantity and going into the stock-room may have the inspection of the lot verified on the routing tag. In case of larger pieces these should be stamped individually with a steel stamp bearing the inspector's distinct symbol.

Stock-keepers and assemblers must not accept pieces on which inspection is required, without proof of inspection. The withdrawal of a part from a stock-room naturally assumes that such piece has been inspected before it was accepted in the stock-room. It is important that such pieces as go direct to assembling or erection, without first going to a stock-room, have the inspector's symbol stamped upon them, or upon the tag accompanying them.

348. Altering Inspected Parts.—Assemblers and erectors must be prohibited from using files or other tools to alter parts already finished and supposed to be correct. If parts will not assemble, the inspection department must be notified.

349. Inspection of Assembled Groups.—As regards the inspection of groups of parts it may be necessary in many cases to have an inspector inspect all the component parts of a group previous to assembling into groups. Such groups and specified component parts should be designated on the bill of material by the engineering department.

Such parts of groups as must be accurate in order to make assembling possible without alteration by assemblers must be designated as to the required inspection on the bill of material.

350. Erection Inspection.—In regard to erection inspection it is necessary that an inspector exercise close scrutiny over machines while in process of erection. He must report defects to the department foreman, and the department foreman and workman must lend any assistance necessary for the proper performance of the inspector's duty.

351. Electrical Inspection.—As regards electrical inspection, all parts having electrical functions are best tested as independent parts before assembling. This applies to such parts as windings, coils, resistances, etc. In order to be doubly sure, and in order to prevent dissatisfaction on the part of customers ordering repair parts, it is often advisable also to apply alternating current, high voltage to all electric current carrying parts, prior to their shipment as renewals, and also to make a magneto test of armatures and commutators prior to shipment, so as to locate any possible short-circuits. The same precautions as to an additional test at the time of issuing of electrical parts from a stock-room to shop for assembling may be considered advisable.

As regards the inspection of assembled groups of electrical parts as to accuracy of connections, where such inspection is advisable, inspectors should be furnished with diagrams showing the connections, such diagrams to be made by the engineering department.

352. Final Inspection and Test of Complete Machines.—The final inspection and test of complete machines should be conducted in accordance with instructions furnished by the engineering department, who should also prepare complete data sheets and log sheets covering the final inspection and test.

353. Organization of Inspection Department.—As regards the organization of the inspection department, it is pretty generally agreed that this department must be independent of any shop control. If the inspection department must be either under the shop superintendent or the chief engineer, it is far better to have it under the chief engineer, because if the inspectors were part of the shop organization, the tendency would be to conform to the ideas of the various department foremen rather than to the letter of the specifications.

In inspection work all specifications must be so worded that there can be no difference between the letter and the spirit of the law. This means that drawings and bills of material must specify very carefully the degree of accuracy required so far as relates to dimensions which require special care, and also that a general written code of requirements be prepared by agreement between the engineering department, the shops, and the inspection department, and all parties involved co-operate to live up to the letter of this code.

354. Qualifications of Inspectors.—The class of labor employed in the inspection department will depend altogether on the duties of the individual inspector.

The inspection of such an article as steel balls, made in quantity, may be satisfactorily conducted by a mere apprentice.

Dimensional inspection of machined pieces will require a man of the capacity of a good vise-hand machinist.

Electrical inspection of parts may in many cases be done satisfactorily by an apprentice electrician. On the other hand, a final electrical test may demand the services of a technically educated man. In a large shop the personnel of the inspection and testing department would include men of various degrees of experience and education.

It will evidently take a man of executive ability and tact as well as a good engineer to fill the position of chief inspector. He will be able to do his duty most satisfactorily if his department is responsible only to the works manager, and neither to the shop superintendent nor to the chief engineer.

355. Errors and Defects.—As an example of how to take care of defective workmanship and material developing in course of manufacture, the following instructions as used in a machinery manufacturing establishment will serve:

"Standing orders have been established as follows, covering defective castings or material of any kind which is defective, also all extra work on account of errors or defects:

Standing Order No. 18.—All labor and material lost on account of defective workmanship in shop.

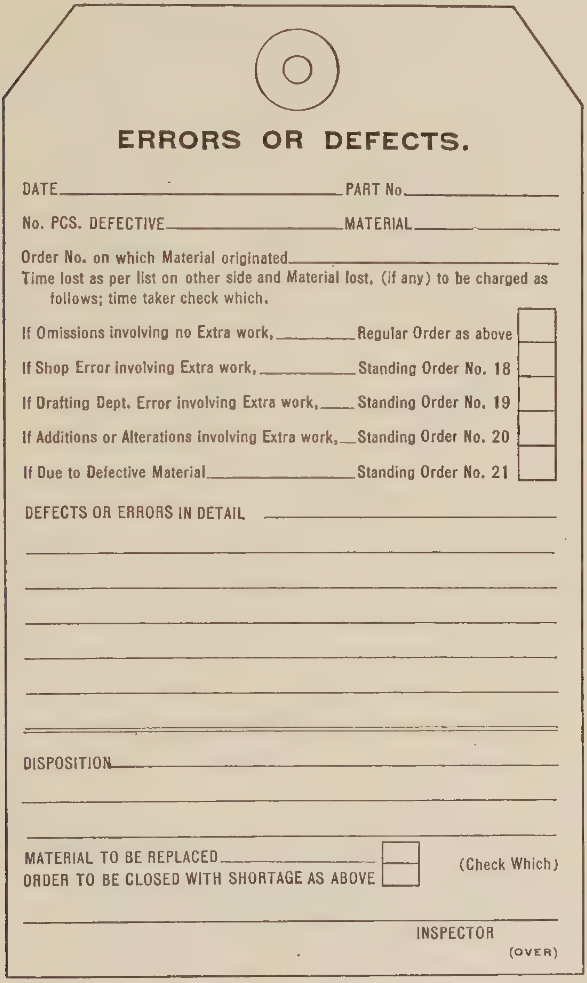
Standing Order No. 19.—All labor and material lost on account of errors in drawings or designs.

Standing Order No. 20.—All labor and material lost on account of additions or alterations due to changes in instructions from purchaser, or improvements in design, conceived during building.

Standing Order No. 21.—All labor and material lost on account of defective material delivered on purchase orders. Proper credit to be made to this order, of such amounts as may be secured in credits from companies responsible for this loss."

"Errors and Defects" tags (Figs. 159 and 160) are to be used in the following manner:

Where material is to be scrapped or returned, this point to be decided by chief floor inspector, the tag will be used in the following manner:



ERRORS OR DEFECTS.

DATE__________ PART No.__________

No. PCS. DEFECTIVE__________ MATERIAL__________

Order No. on which Material originated__________

Time lost as per list on other side and Material lost, (if any) to be charged as follows; time taker check which.

If Omissions involving no Extra work,_____Regular Order as above ☐

If Shop Error involving Extra work,_____Standing Order No. 18 ☐

If Drafting Dept. Error involving Extra work,_____Standing Order No. 19 ☐

If Additions or Alterations involving Extra work,_____Standing Order No. 20 ☐

If Due to Defective Material_____Standing Order No. 21 ☐

DEFECTS OR ERRORS IN DETAIL__________

DISPOSITION__________

MATERIAL TO BE REPLACED_____ ☐ (Check Which)

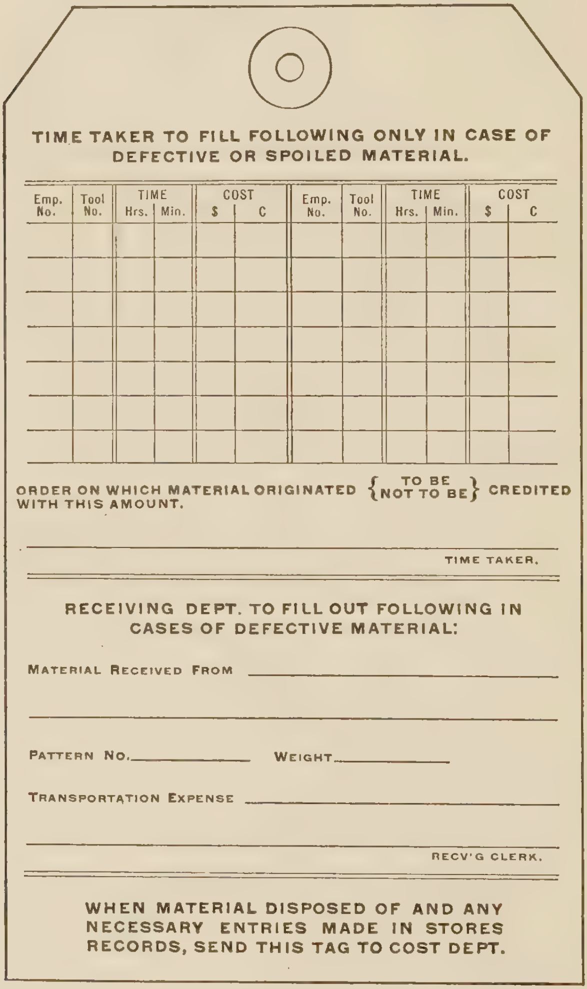
ORDER TO BE CLOSED WITH SHORTAGE AS ABOVE ☐

INSPECTOR

(OVER)

Fig. 159.—Error or defect tag. (Front.) Manila tag stock, 4 1/8 inches wide, 7 inches high.

If ordered scrapped on account of some shop error, no defect being in casting, chief floor inspector will write "scrap" on error tag, and will have department time-taker enter time on back of error tag in place provided for same. He then sends a laborer to the receipt window of the storeroom with the part or parts. The storeroom clerk removes the tag and sends same to stores record clerk at the same time that he sends in regular production tags covering the day's receipts of finished parts from the shop, and sends the rejected material to the proper scrap bin.



TIME TAKER TO FILL FOLLOWING ONLY IN CASE OF DEFECTIVE OR SPOILED MATERIAL.

Emp. No.	Tool No.	TIME		COST		Emp. No.	Tool No.	TIME		COST	
		Hrs.	Min.	$	C			Hrs.	Min.	$	C

ORDER ON WHICH MATERIAL ORIGINATED {TO BE / NOT TO BE} CREDITED WITH THIS AMOUNT.

TIME TAKER.

RECEIVING DEPT. TO FILL OUT FOLLOWING IN CASES OF DEFECTIVE MATERIAL:

MATERIAL RECEIVED FROM

PATTERN NO. WEIGHT

TRANSPORTATION EXPENSE

RECV'G CLERK.

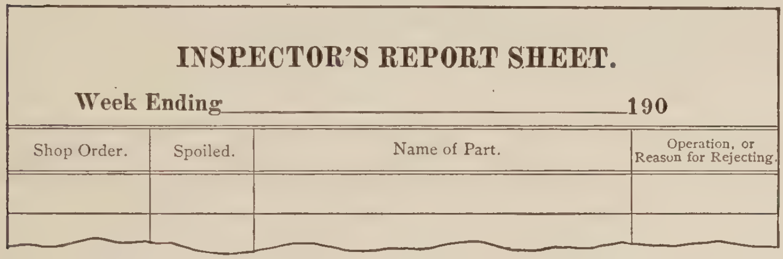
WHEN MATERIAL DISPOSED OF AND ANY NECESSARY ENTRIES MADE IN STORES RECORDS, SEND THIS TAG TO COST DEPT.

FIG. 160.—Error or defect tag. (Back.) (See Fig. 159.)

In case of defective material, the above procedure is followed, except that parts, instead of going to stores department, are sent to receiving department, where necessary entries are made in spaces provided for same on back of tag, and proper shipping tag is attached for return of material to party furnishing same, the error tag being then removed and sent to stores record clerk.

Errors not involving scrapping or returning of material are handled as follows:

Floor inspector will decide to which standing order extra time is to be charged, time-takers making such entries on current time records. In all cases where it is a matter of putting into acceptable condition parts which can be put in such condition, the time to be charged to the standing order will be only that required to make the part acceptable. If extra work by reason of errors or defects is not discovered until extra time beyond what it should have taken has already been posted to a productive order, the production order will be credited with the amount, which is to be posted to the standing order. Provision for this is made on the back of the form.



INSPECTOR'S REPORT SHEET.

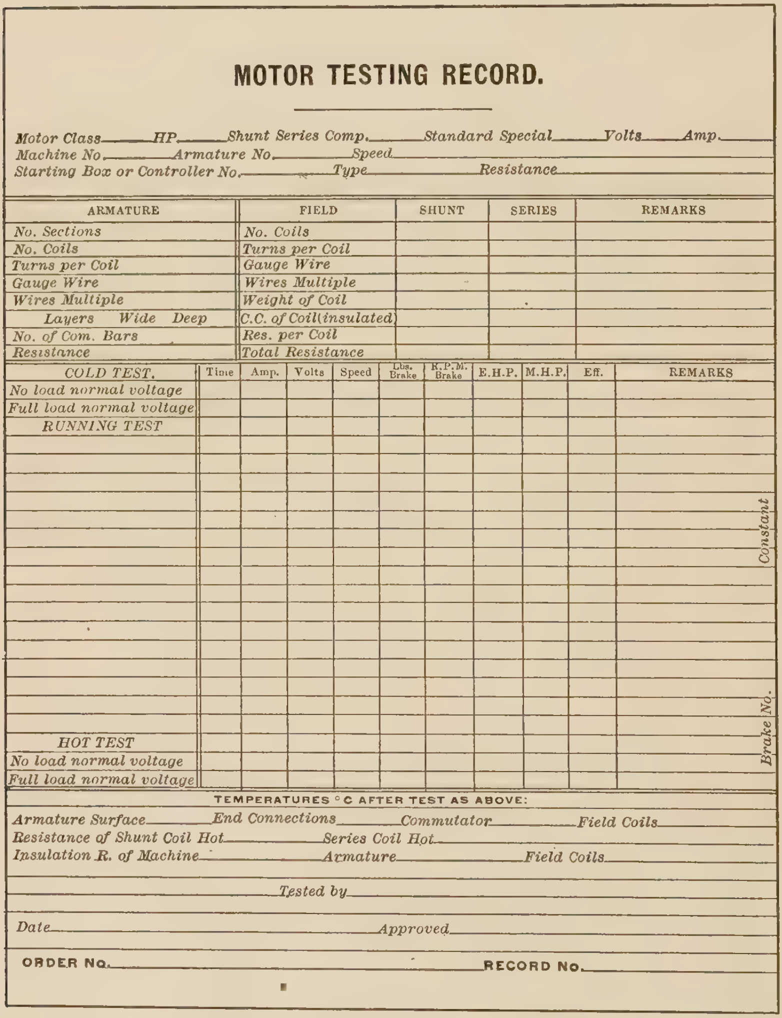
Week Ending______________________________190

Shop Order.	Spoiled.	Name of Part.	Operation, or Reason for Rejecting.

FIG. 161.—Inspection department weekly report. White paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.

It is exceedingly important that whenever it is determined that time or material are to be charged to these standing orders, the corresponding error tags be written out immediately by floor inspector and the goods with the tag sent promptly to the department that should receive same. Every department receiving goods with error tags should do everything possible to hasten the arrival of the material at its proper destination, and of the tag at its final destination, namely, the cost department.

Whenever parts are returned to shop for further work from general inspection department at storeroom receiving gate to the shop, inspection department attaches an error tag, properly filled out. When inspector has a number of pieces in one lot, of which part are defective and have to go back to the shop, and part are good, he sends the good portion with the regular shop production tag to storeroom, noting on the shop tag the number which he has returned to the shop. In such cases the error tag



MOTOR TESTING RECORD.

*Motor Class*______*HP.*______*Shunt Series Comp.*______*Standard Special*______*Volts*______*Amp.*______
*Machine No.*______*Armature No.*______*Speed*______
*Starting Box or Controller No.*______*Type*______*Resistance*______

ARMATURE	FIELD	SHUNT	SERIES	REMARKS
No. Sections	*No. Coils*			
No. Coils	*Turns per Coil*			
Turns per Coil	*Gauge Wire*			
Gauge Wire	*Wires Multiple*			
Wires Multiple	*Weight of Coil*			
Layers Wide Deep	*C.C. of Coil (insulated)*			
No. of Com. Bars	*Res. per Coil*			
Resistance	*Total Resistance*			

COLD TEST.	Time	Amp.	Volts	Speed	Lbs. Brake	R.P.M. Brake	E.H.P.	M.H.P.	Eff.	REMARKS
No load normal voltage										
Full load normal voltage										
RUNNING TEST										
										Constant
HOT TEST										*Brake No.*
No load normal voltage										
Full load normal voltage										

TEMPERATURES °C AFTER TEST AS ABOVE:

*Armature Surface*______*End Connections*______*Commutator*______*Field Coils*______
*Resistance of Shunt Coil Hot*______*Series Coil Hot*______
*Insulation R. of Machine*______*Armature*______*Field Coils*______

*Tested by*______

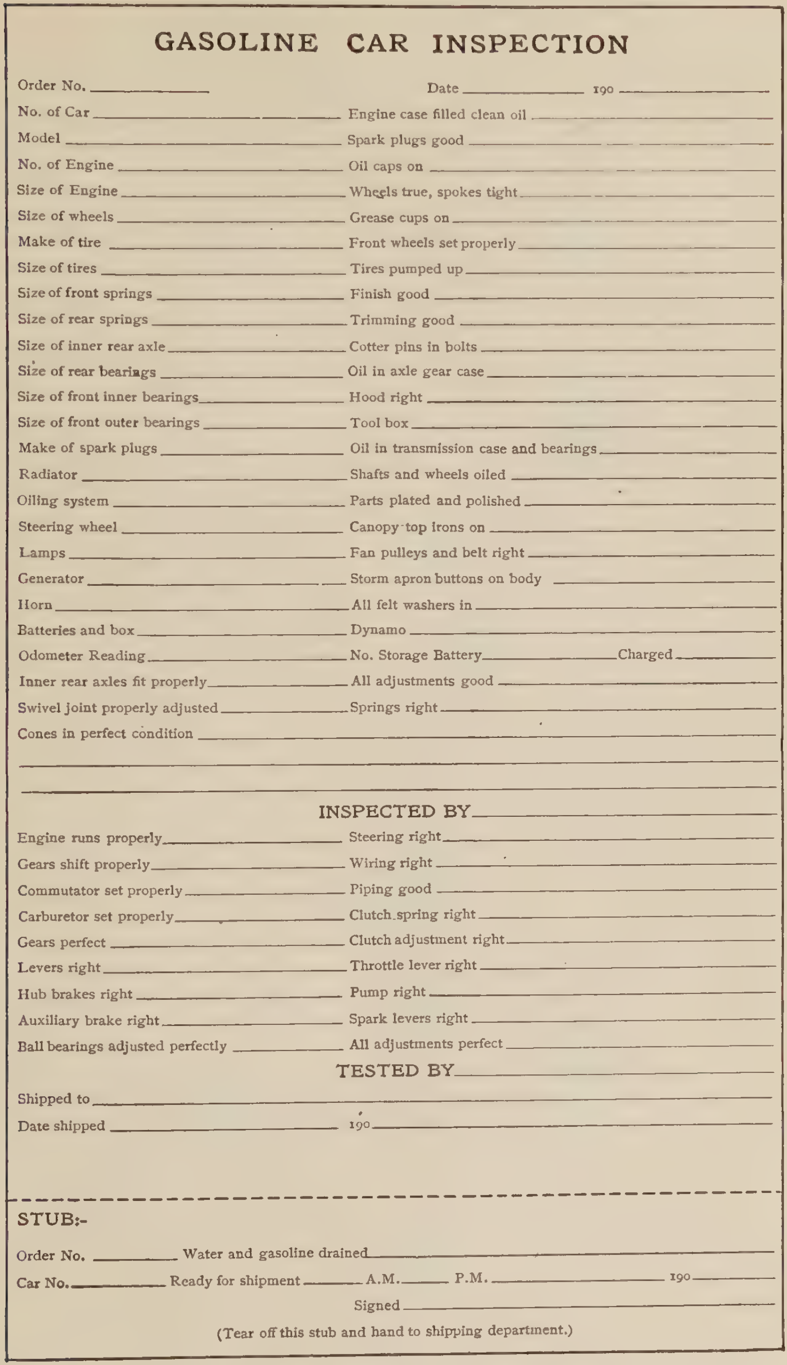
*Date*______*Approved*______

ORDER NO.______RECORD NO.______

Fig. 162.—Form for reporting motor test. White bond paper, 8 1/2 inches wide, 11 inches high, ruled in red and blue.

takes the place of the regular production tag on the pieces having extra work done on them in the shop.

Inspectors should keep a record of all errors and defects, and



GASOLINE CAR INSPECTION

Order No.

Date 190

No. of Car
Model
No. of Engine
Size of Engine
Size of wheels
Make of tire
Size of tires
Size of front springs
Size of rear springs
Size of inner rear axle
Size of rear bearings
Size of front inner bearings
Size of front outer bearings
Make of spark plugs
Radiator
Oiling system
Steering wheel
Lamps
Generator
Horn
Batteries and box
Odometer Reading
Inner rear axles fit properly
Swivel joint properly adjusted

Engine case filled clean oil
Spark plugs good
Oil caps on
Wheels true, spokes tight
Grease cups on
Front wheels set properly
Tires pumped up
Finish good
Trimming good
Cotter pins in bolts
Oil in axle gear case
Hood right
Tool box
Oil in transmission case and bearings
Shafts and wheels oiled
Parts plated and polished
Canopy-top irons on
Fan pulleys and belt right
Storm apron buttons on body
All felt washers in
Dynamo
No. Storage Battery Charged
All adjustments good
Springs right

Cones in perfect condition

INSPECTED BY

Engine runs properly
Gears shift properly
Commutator set properly
Carburetor set properly
Gears perfect
Levers right
Hub brakes right
Auxiliary brake right
Ball bearings adjusted perfectly

Steering right
Wiring right
Piping good
Clutch spring right
Clutch adjustment right
Throttle lever right
Pump right
Spark levers right
All adjustments perfect

TESTED BY

Shipped to
Date shipped 190

STUB:-

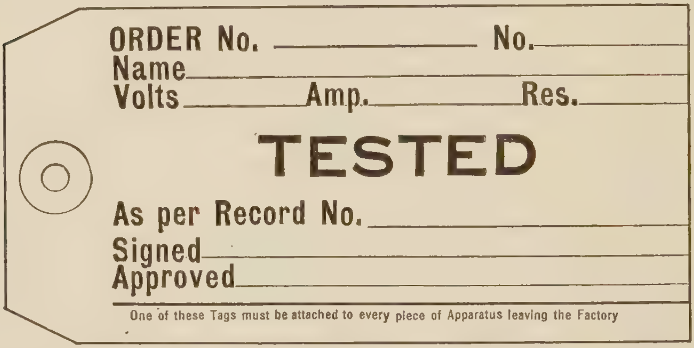
Order No. Water and gasoline drained
Car No. Ready for shipment A.M. P.M. 190
Signed

(Tear off this stub and hand to shipping department.)

FIG. 163.—Form for combined inspection and test of gasoline-driven automobile. Buff bond paper, 8 1/2 inches wide, 11 inches high.

these records of all inspectors should be assembled into a weekly report sheet, similar to Fig. 161.

356. Testing Distinct from Inspection.—Testing of assembled machines is usually carried on by a department distinct from the inspection department, the testing being usually under the supervision of the chief engineer or the engineering department.



ORDER No. ____________ No. ____________
Name ____________
Volts ________ Amp. ________ Res. ________

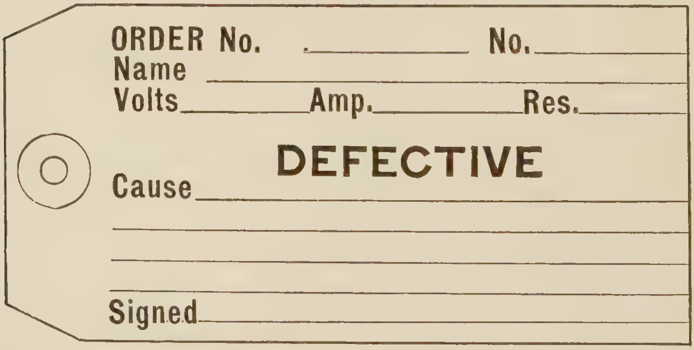
TESTED

As per Record No. ____________
Signed ____________
Approved ____________

One of these Tags must be attached to every piece of Apparatus leaving the Factory

FIG. 164.—Test tag attached to finished product by testing department. Red tag stock, 4 3/4 inches wide, 2 1/2 inches high.

357. Test Reports and Records.—Fig. 162 shows a form for reporting motor test. Fig. 163 shows a form for combined inspection and test record of a gasoline-driven automobile.



ORDER No. ____________ No. ____________
Name ____________
Volts ________ Amp. ________ Res. ________

DEFECTIVE

Cause ____________
____
____
____
Signed ____________

FIG. 165.—Defective tag attached to finished product by testing department. Blue tag stock, 4 3/4 inches wide, 2 1/2 inches high.

Figs. 164 and 165 are "Tested," and "Defective" tags as used by testing department employees in electrical work.

REFERENCE

PARKHURST: "Applied Methods of Scientific Management," Chapter III.

CHAPTER XXV

RATE FIXING AND TIME STUDIES

358. Former Time Standards not a Reliable Basis for Rate Fixing.—The simplest method of rate-fixing which is apt to suggest itself to the novice, and especially to a man whose duties have been clerical rather than mechanical, is to average past time records as listed in the cost record, as a basis for time standards. This method is perhaps safe in estimating selling prices, but is seldom safe to use as a basis for piece-work, premium, bonus, or efficiency wage systems. The reason for the foregoing statement is that accurate time and motion study almost invariably reveals useless motions and suggests improvements which will lead to determining the best method, which usually involves far less time than former methods.

359. Analysis of Work into Preparatory and Supplementary Steps and Active Work.—The correct basis for time standards is the least possible time required to do the operations involved and turn out a product that will pass the inspecting department as satisfactory, allowing such frequency and length of rest periods as will prevent fatigue. In the machine shop this time is made up of two parts: first, that spent in preparatory and supplementary work, such as jigging, chucking, taking out, gaging, etc.; second, that spent in active work while the machine is in operation.

The time that should be spent in active machine work is a matter that can easily be determined. In machine tool work where one workman operates a single spindle it will be limited only by the highest speed that the tools and machinery will stand. In multiple spindle work there is no advantage in the cutting operation being done more rapidly than the shortest time that will permit of continuous active work on the part of both operator and machine. The handling time is less easily determined than machine time as it involves motion study together with assignment of proper rest intervals, where such are needed.

360. Rate Fixing on Non-repetitive or "Job" Work.—It is evident that in a purely manufacturing establishment the variable factors involved in the handling steps can be determined with a far greater amount of certainty than in jobbing work, since in the former case the operation is being done on the same piece in the same manner day after day. A jobbing shop may, with advantage, go so far as to prepare a routing tag for every piece, and specify the maximum feed and speed attainable in machining, and also the minimum time that it is estimated should be taken in the chucking, handling, etc. But in the jobbing shop the average workman is not expected to accomplish the work in the minimum time thus set, since he does not repeat the work often enough to get into a fast gait. Hence the premium wage system with its fixed day rate is gaining in favor in jobbing shops. In fact, there are instances of the premium system being combined successfully with a bonus of a fixed daily amount for the accomplishment of all tasks undertaken and completed in a specific time. In fixing the time it should take a man working continuously on the same operation to accomplish his work, it is only fair to expect him to turn out the work far more rapidly than would be expected in a jobbing shop. Most modern machine-shop work is so much relieved of heavy labor that lively movement on the part of the worker is no hardship. Where the work is heavy, time allowances will have to be made for pauses and intervals of rest.

Rate-fixing intelligently undertaken will make the rate right at the outset and hence there will never be any thought of changing it. Piece rates can be made correct at the outset if the work of rate-fixing is correctly done, and based upon scientific research rather than upon the guessing which is often misnamed "judging."

361. Foreman's Time Standards Usually Guess Work.—The usual method of fixing piece rates has been for the foremen to decide what the rates should be. In many cases it is quite customary for a foreman to have his time-keeper jot down the names or symbols of pieces on which work is being done, and on which no piece rates have been set. These memoranda are allowed to accumulate until a few hours before it is necessary to advise the pay-roll department of new piece rates, with the result that the work of rate-fixing is done very hastily. The foundations on which foremen are generally accustomed to base piece rates are previous prices paid for similar pieces and what foremen choose to call their "judgment." Notes based on actual observations of the work are seldom taken, and very rarely are observations recorded on the distinct elements or steps in operations.

The general tendencies and attitudes of one foreman will be very different from those of another. The natural result is thát similar work is differently compensated in different departments of a factory where the foremen are wholly responsible for piece-work rates.

I do not believe it at all wise to attempt to take away from foremen certain rights with regard to the establishment of piece rates. On the one hand, the foreman has no right to consider himself the supreme authority in his department. The owners of a business certainly have rights in the important question of wages. On the other hand, the foreman feels that he is responsible for the output of his department, and it is not only fair but absolutely essential that his concurrence be secured at every step taken. The ability to secure such concurrence, and the good-will of foremen in general, is an indispensable qualification of the man who is to take charge of a rate-fixing bureau.

362. Analysis of Machine Speeds and Feeds to be Undertaken Prior to Rate Fixing.—A careful investigation of speeds of all machine tools is a prerequisite to the institution of a rate-fixing bureau. This investigation will consist in recording the speeds of line shafts, countershafts, and all spindles, together with all steps of cone pulleys, and all variations in speed to be obtained by change gears or any other device. A card record should be established, indexed by departments, and cross-indexed to show all like tools, the individual cards bearing numbers coincident with the serial permanent inventory number attached to each machine tool. On these cards will be recorded the make, style, and age of the machine, together with the speed data above referred to. The proper pulley or gear combination for various diameters of stock at various cutting speeds can also be tabulated on these record cards.

The preparation of the speed record will take considerable time, probably some months. During this time the workmen will have become accustomed to the unconcealed use of the stop-watch by one or more observers. The extreme delicacy with which the stop-watch question is here treated may be surprising to some readers. However, in centers of constant labor agitations every possible agency that may be the spark to ignite the strike-fire is necessarily dealt with cautiously.

After several months' use of the stop-watch in the collection of data necessary for the speed record, it is not likely that any trouble will be created by the use of the watch in recording the time required in the various handling operations.

The preliminary work in connection with the preparation of the speed and machine record may advantageously be accompanied by an investigation of the merits of various makes of tool steel as adapted to the special work in hand.

To one who is not familiar with the possibilities of machine tools when correctly operated it is recommended that he read A. S. M. E., paper No. 1010, Vol. XXV, by Carl G. Barth on "Slide Rules for the Machine Shop," and also A. S. M. E., paper No. 1119, Vol. XXVIII, by F. W. Taylor on "The Art of Cutting Metals."

While Barth's slide rules are instruments which usually require the personal attention of the inventor to introduce successfully, a careful study of Mr. Barth's paper as well as Mr. Taylor's monumental treatise above referred to will disclose to a painstaking, educated and skilful machine-shop manager all the data that are required to predetermine for any piece requiring metal removal, the "one best way" of doing it, together with the means for determining the time required to do the work in that way.

363. Instruments and Devices Needed for Time Study.—In taking observational data which are to be used as a basis for piece rates, certain simple tools and instruments are indispensable, namely, surface speed indicator, revolution counter, calipers, scales, and, unfortunately, the stop-watch. Various expedients have been tried and suggested for the concealing of the stop-watch, but I have yet to learn of any such ruse which will not be discovered and word of it spread all over a shop in a very limited time.

Within recent years Frank Gilbreth has made use of the motion picture camera to analyze motions. In range of the camera he sets up a large clock mechanism with a pointer revolving once a minute, the circle being divided into hundredths or even thousandths. The time is of course recorded on the films by the photograph of this large stop-clock. The films are afterward carefully analyzed for the purpose of determining the best methods and eliminating wrong ones. This method Mr. Gilbreth has designated as micro-motion study.

364. Idle Time of Machines.—Any one who has been engaged for some time in shop-time study work will soon discover that the largest losses are as a rule not due nearly as much to running machines too slowly as to absolute stoppage of the machine while the operator is away. It would be unfair to say that the operator is killing time; certainly the machine is. Mr. George F. Card has devised a machine for recording the working and stopping time of machine tools, so that all running time of the machine is shown on a dial by a mark. When the machine is at rest a space appears. This machine will tell the exact time when tools are started and stopped. It does this by means of a contact piece on the belt shifter or elsewhere on the machine tool, so that an electromagnet operating a pen holds the pen against the paper when the tool is running, and when the tool is at rest the pen is held away. The paper dial on which the pen makes its record is operated by clockwork. A separate clock located directly above the one which operates the dial is stopped whenever the pen is lifted, and it is started as soon as the pen comes into contact with the paper. This clock then, which is set at 12 as the starting time, records the total running hours and minutes of the machine in a day.

A number of machines may be wired up to a board containing snap-switches, the snap-switches being so arranged that each circuit leading to them may be thrown on or off of the clock recorder. In this way observations may be taken for a day on any one of a group of machines without the men in the shop knowing which one of the machines is being recorded. Of course, the record does not show when the machine is "cutting wind," that is, when the machine is moving but not cutting metal.

When observational data are being taken attention must be given to this last possibility. Such a device will not, by any manners of means, take the place of observational time study, but it may be made a supplement to it by recording the time between stops taken by the machine operator when he is not being observed; also the length of the stops.

365. Taylor's Description of Correct Time Study.—Taylor classifies time study into two broad divisions: first, analytical work; second, constructive work.

The analytical work of time study is as follows:

a. Divide the work of a man performing any job into simple elementary movements.

b. Pick out all useless movements and discard them.

c. Study, one after another, just how each of several skilled workmen makes each elementary movement, and with the aid of a stop-watch select the quickest and best method of making each elementary movement known in the trade.

d. Describe, record and index each elementary movement, with its proper time, so that it can be quickly found.

e. Study and record the percentage which must be added to the actual working time of a good workman to cover unavoidable delays, interruptions, and minor accidents, etc.

f. Study and record the percentage which must be added to cover the newness of a good workman to a job, the first few times that he does it. (This percentage is quite large on jobs made up of a large number of different elements composing a long sequence infrequently repeated. This factor grows smaller, however, as the work consists of a smaller number of different elements in a sequence that is more frequently repeated.)

g. Study and record the percentage of time that must be allowed for rest, and the intervals at which the rest must be taken, in order to offset physical fatigue.

The constructive work of time study is as follows:

h. Add together into various groups such combinations of elementary movements as are frequently used in the same sequence in the trade, and record and index these groups so that they can be readily found.

i. From these several records, it is comparatively easy to select the proper series of motions which should be used by a workman in making any particular article, and by summing the times of these movements, and adding proper percentage allowances, to find the proper time for doing almost any class of work.

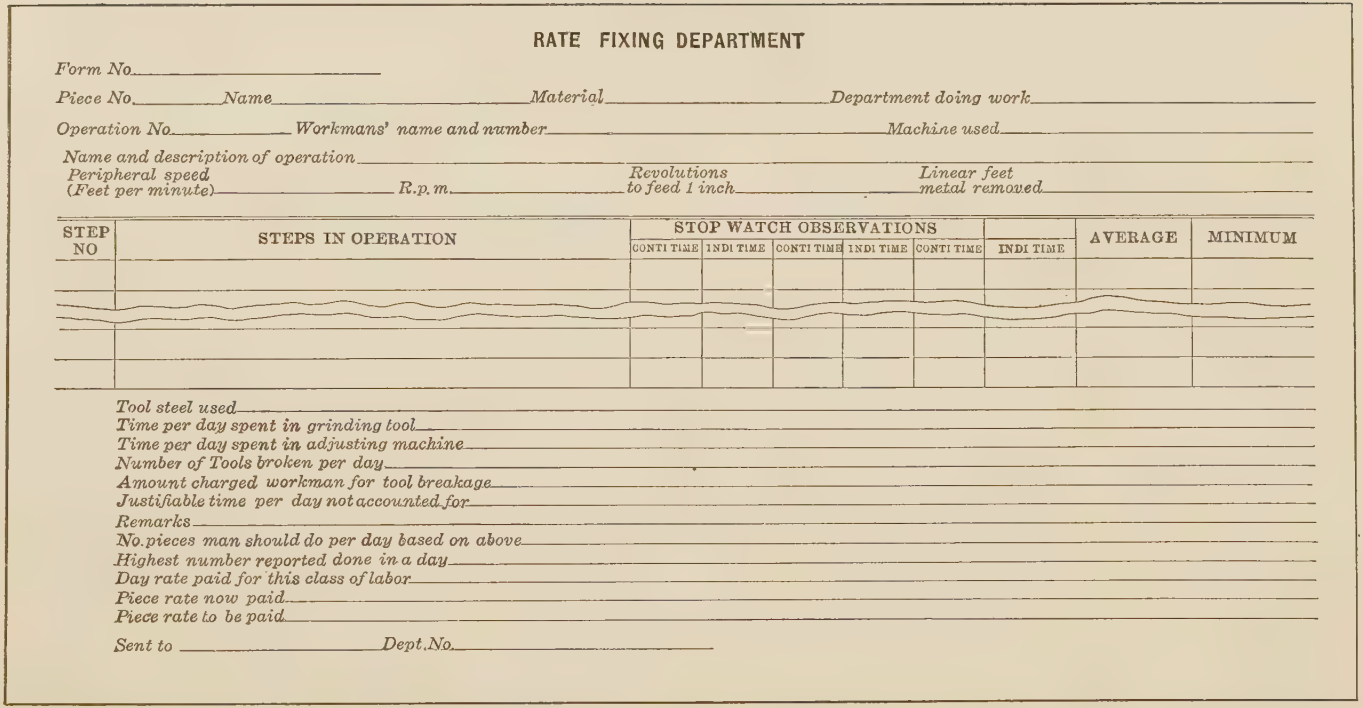
j. The analysis of a piece of work into its elements almost always reveals the fact that many of the conditions surrounding and accompanying the work are defective; for instance, that improper tools are used, that the machines used in connection with it need perfecting, and that the sanitary conditions are bad, etc. And knowledge so obtained leads frequently to constructive work of a high order, to the standardization of tools and conditions, to the invention of superior method and machines.

366. Confining Rates to New Operations and New Pieces.— After completion of the preliminary work, the real work of rate fixing may begin by taking observations and establishing rates on all new pieces, with the foremen's co-operation, at the same time beginning observations on some single machine, taking piece by piece and operation by operation.

If a prior time-standard or rate is of such a nature that it allows too long a time or too high a pay, it must not under any circumstances be changed. The only way to get rid of such an error is to redesign the piece or change the process. Even this recourse is to be avoided if at all possible.

367. Form for taking Observations for Time Studies.—A form used by the writer for an observation memorandum is shown in Fig. 166. In many cases not all of the data called for will be obtainable or necessary. Individual tastes will determine the exact size and shape of such a form. A book has always the disadvantage that the original data sheets cannot be easily classified and filed away, as is the case with a loose-leaf system. Referring to the form, the items calling for time spent in grinding tools, time spent in adjusting machine, and justifiable time per day not accounted for, will constitute difficult observational data. They would be best estimated by a whole day's observation on some typical piece of work which could be used as a basis to cover a group of similar jobs. In an establishment where special tool-grinding departments are maintained, the item covering time spent in grinding tools will, of course, drop out. There are few factories in which it would not be advantageous to maintain a tool-grinding and storage department. The claim has been made that each man likes his tool ground in his own way, and becomes attached to some particular tool which he might not get back from a general grinding room. These points are offset by the fact that some men are much harder on tools than others, and that a skilled grinder will be able often with a few words to tell them where their trouble lies. One of the best arranged tool storage and grinding rooms the writer has seen is provided with standard removable bin units, two wide and four high, each bin containing an easily removable interchangeable filler. The numbered spaces containing the tools are plainly visible. This method of storing tools saves a great deal of time over any storage method employing drawers or boxes.

In securing the observational data, the personality of the observers is a matter of great importance. A carefully selected man can go into the works and take all the observations necessary, and at the same time have the good-will and friendship of both men and foremen. Another man doing exactly the same routine work might easily, and unconsciously to himself, be considered offensive by the shop hands. The qualifications essential



RATE FIXING DEPARTMENT

*Form No.*__________

*Piece No.*_____ *Name*__________ *Material*__________ *Department doing work*__________

*Operation No.*_____ *Workmans' name and number*__________ *Machine used*__________

*Name and description of operation*__________

*Peripheral speed (Feet per minute)*_____ *R.p.m.*_____ *Revolutions to feed 1 inch*_____ *Linear feet metal removed*_____

STEP NO	STEPS IN OPERATION	STOP WATCH OBSERVATIONS						AVERAGE	MINIMUM
		CONTI TIME	INDI TIME	CONTI TIME	INDI TIME	CONTI TIME	INDI TIME		

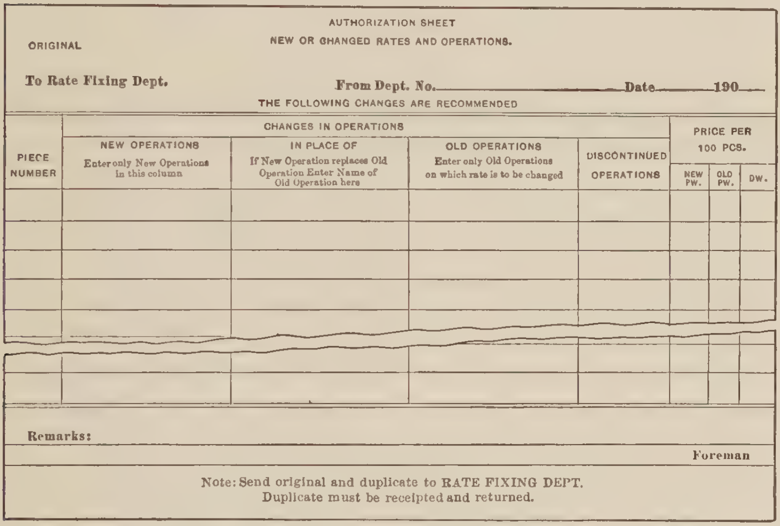
*Tool steel used*__________
*Time per day spent in grinding tool*__________
*Time per day spent in adjusting machine*__________
*Number of Tools broken per day*__________
*Amount charged workman for tool breakage*__________
*Justifiable time per day not accounted for*__________
*Remarks*__________
*No. pieces man should do per day based on above*__________
*Highest number reported done in a day*__________
*Day rate paid for this class of labor*__________
*Piece rate now paid*__________
*Piece rate to be paid*__________

Sent to __________ *Dept. No.*__________

FIG. 166.—Form for recording observational data used in fixing time standards. White bond paper, 11 inches wide, 8 1/2 inches high.

for such observers are, first, a sound and discriminating judgment based on an inherent sense of justice; second, ability to take and appreciate the value of precise observations, such as is developed in laboratory training; third, an unassumed spirit of democracy and modesty; fourth, ability to stand one's ground without creating antagonism. In short, character and tact will be the chief requisites.

368. Computations and Statistics as an Aid to Observations.—In addition to taking observational data, a rate-fixing department should prepare such statistical data and charts as will be valuable in predetermining and checking time standards. After taking such field notes as may be desirable, the observer goes to the department office and "works up" his notes; *i.e.*, he determines on what he considers a fair time standard for each operation observed, and investigates also the statistics on file, using the statistical information as secondary and not primary reference. After he has thoroughly worked up the results of his study, the observer visits the foremen of the departments in which he took observations, with a view to co-operating with the foremen in establishing new standards.



AUTHORIZATION SHEET
ORIGINAL
NEW OR CHANGED RATES AND OPERATIONS.

To Rate Fixing Dept.
From Dept. No.________________ Date________190__
THE FOLLOWING CHANGES ARE RECOMMENDED

PIECE NUMBER	CHANGES IN OPERATIONS				PRICE PER 100 PCS.		
	NEW OPERATIONS Enter only New Operations in this column	IN PLACE OF If New Operation replaces Old Operation Enter Name of Old Operation here	OLD OPERATIONS Enter only Old Operations on which rate is to be changed	DISCONTINUED OPERATIONS	NEW PW.	OLD PW.	DW.

Remarks:

Foreman

Note: Send original and duplicate to RATE FIXING DEPT.
Duplicate must be receipted and returned.

FIG. 167.—Sheet for changed rates and operations. The sheet is 7 1/4 inches wide and 11 inches high, white paper. A duplicate, pale buff in color, is attached directly behind the original.

369. Notice of New Rates.—The foreman's interest and co-operation is always essential. Hence the authorization sheet should be signed by the foreman, and its arrival in the office of the rate-fixing department should be evidence that the rates have been sanctioned by both foreman and observer. A form suggested for this authorization sheet is shown in Fig. 167.

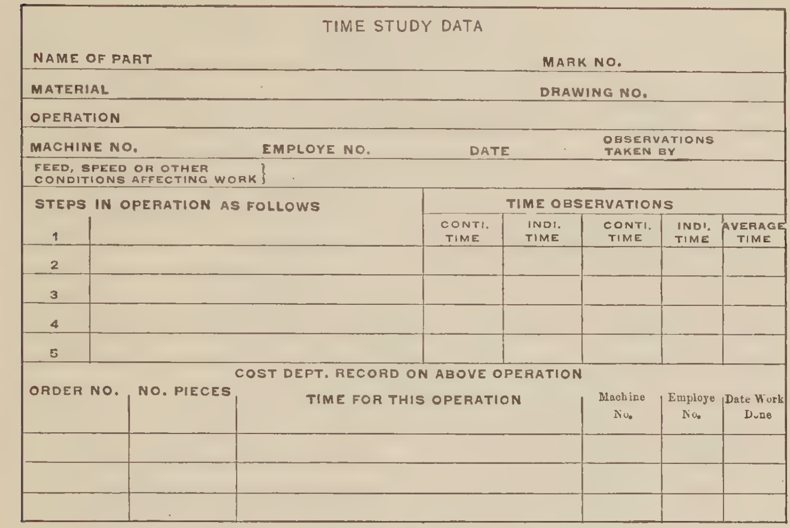
A card index of all piece rates is kept in the rate-fixing department office by postings from the observation and authorization sheets. The general form and arrangement of this card index will depend upon the nature of the business and product.

The regular routine of the work of the department would consist of a methodical review of all existing rates, accompanied by a continuous system of notices of all new work undertaken. Notices are sent by the head time clerk to the rate-fixing department of any new pieces on which work is begun, and on which new rates are desired, and an observer from the rate-fixing department responds at once to this call.

370. Time Study and Rate Fixing to be Permanent Rather than Temporary.—A regular routine system as above laid out will be far preferable to an occasional and more or less disconnected series of observations used merely as a stimulus to greater accuracy on the part of foremen. There is danger of the foremen regarding the work as less authoritative, and considering that it is being done in a half-hearted way, unless it has the impetus and swing of a regular routine system.

The number of men to be employed in instituting a work of this kind will depend wholly upon the number of pieces to be investigated, and their similarity. The qualifications of the men are such that they are likely to be as high salaried as the best foreman. While the employment of additional so-called non-productive labor is not in line with any policy of retrenchment, it is evident that present conditions in many large factories are such that the right kind of men working on time standards and rate fixing could save their salaries many times in a year.

371. Abridged Time Studies for Transient Work.—The form presented in the preceding discussion for recording observational data (Fig. 168) presumes that a great many pieces will be made identical with the one upon which the observation data are taken. Herein lies the only justification for going into such minute detail. It is frequently desirable to secure time-study data for the purpose of establishing premium or bonus times where the number of pieces of one kind is not large enough to justify the expense of going into such minute detail. Under these circumstances an abridgment, which need be none the less accurate, is suggested in Fig. 168. Whenever the time study is to be the basis of an instruction card, however, the motion analysis should be worked out in complete detail.



TIME STUDY DATA

NAME OF PART MARK NO.
MATERIAL DRAWING NO.
OPERATION
MACHINE NO. EMPLOYE NO. DATE OBSERVATIONS TAKEN BY
FEED, SPEED OR OTHER CONDITIONS AFFECTING WORK }

STEPS IN OPERATION AS FOLLOWS		TIME OBSERVATIONS				
		CONTI. TIME	INDI. TIME	CONTI. TIME	INDI. TIME	AVERAGE TIME
1						
2						
3						
4						
5						

COST DEPT. RECORD ON ABOVE OPERATION

ORDER NO.	NO. PIECES	TIME FOR THIS OPERATION	Machine No.	Employe No.	Date Work Done

FIG. 168.—Short form for time-study data. Yellow bond paper, 6 inches wide, 4 inches high.

REFERENCES

GILBRETH: "Primer of Scientific Management," Chapters I and II.
BARTH: "Slide Rules for the Machine Shop," A. S. M. E., paper No. 1010.
TAYLOR: "The Art of Cutting Metals," A. S. M. E., paper No. 1119.
GILBRETH: "Motion Study."
GANTT: "Work, Wages and Profit," Chapters I and II.

CHAPTER XXVI

WAGE SYSTEMS

372. Wage System Must be Adapted to Conditions.—The object of this discussion is to present briefly the various methods of remuneration for labor that are currently in use. It will be the endeavor to demonstrate to what conditions each method is best applicable, and to suggest for each method an outline for a system of management and statistics which will produce the highest efficiency in each method.

Although there is a great variety of methods of compensation, all of these methods may be grouped clearly under three heads, namely, day work, piece work, and gain-sharing methods.

313. Fixed Hourly or Day Rate.—Remuneration by a fixed daily wage assumes that there is a current market rate for competent services in any certain craft. The day rate prevailing in any particular establishment will be governed by such factors as the degree of expertness in craftsmanship or trade necessary for satisfactory results in the particular industry; secondly, by the geographical location of the establishment, which in turn will determine the allowable manufacturing cost of product as it is influenced by cost of transportation to the sales market. Shops whose sales market does not cover a very large area will not have a very heavy transportational or selling expense. However, this condition usually exists only in areas of dense population where the cost of living is high; hence the wage rate is higher in such shops for the same grade of work in any particular trade than is the case in shops located away from the centers of greatest population density.

There are many classes of work where the human labor element is wholly controlled by the output of certain machines, the operator having no opportunity for initiative in making his services of greater value. This is the only class of labor in which day work pure and simple is the best, and in fact the only method from an economic standpoint. On the other hand, in shops small enough that the manager may keep in close touch with the individual personnel, which means shops of not over one hundred employees, it is possible to attain high efficiency under a day-rate system, provided the wage rate is high and careful statistics of labor efficiency are kept. In still smaller shops, say of forty or fifty men, where each man and his work are under the direct scrutiny of a boss or foreman thoroughly familiar with a high-grade standard of quality and quantity of output, good results are obtained under the day-rate system even without the keeping of any statistical records of labor efficiency. It should ever be borne in mind, however, and considered, that there is constantly a possibility that, if an inducement is offered, men will make some improvement in machinery and methods of work. Many shops having a complex output dependent in quality and quantity upon individual initiative and skill adhere to day-rate compensation. Some shop-owners claim that their management is so good that they know intuitively how long every job ought to take, and that simply by observation they can tell when certain men are not giving them a fair day's work, and let such men go. Close scrutiny into these shops will inevitably result in disclosing conditions of variable efficiency. A wide-spread impression prevails that the day wage is the only practicable one in work which requires great care, which cannot be hurried, which cannot be slighted. This assumes that if only given sufficient time to do work, the man doing the work will be conscientious enough to do it thoroughly, an assumption which is not always proven to be correct by actual experience. A successful daywork as well as a successful piece system or merit system must be prepared with careful reference to quality. When a considerable number of men is employed on work in which quality or accuracy is vital, an inspection system must go hand in hand with any system of remuneration. Well-known companies who had at first some difficulty with merit systems, owing to slighting of work, frankly state that since proper inspection has been provided for, they have far less trouble on account of quality than they used to have under the day-wage system, since the men know that they dare not slight quality if they hope to gain the benefits of the merit wage.

The principal danger with the day-rate system lies in the tendency toward establishing a dead level of production which is low. It is possible to remunerate in a day-pay system the best workingman at a higher hourly rate than the average. However, times are bound to occur when, for instance, a man who has been promoted on account of exceptionally good services to a rate of, say, 32 1/2 cents an hour will be assigned the identical work which another man is doing who may be receiving but 25 or 27 1/2 cents an hour. This occurrence is always taken advantage of by the lower priced man, who asks for a raise in wages, and it is pretty hard to keep him from becoming dissatisfied. Day pay does not furnish the stimulus for development of initiative or creative ability which is presented by the gain-sharing methods.

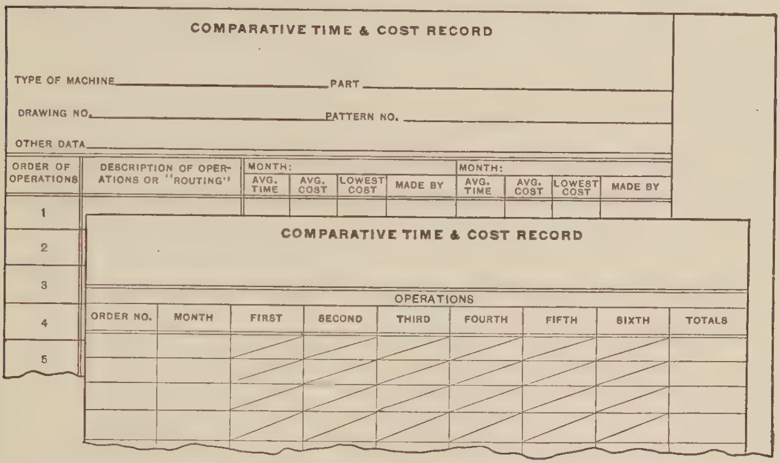
So far as pay-roll systems are concerned in connection with the day-rate method, the only thing necessary is a recording time-clock. Pay-roll will be made up from the time-clock strips or cards.

374. Efficiency Records under Day-rate.—In order to determine workmen's efficiency as craftsmen, it is necessary to have some system whereby comparative records are made of time required to do individual operations. Such systems are absolutely essential in order to bring a day-rate system to a state of higher efficiency. When these systems are once installed it requires but very little additional labor to take care of the pay-roll and statistics of a gain-sharing system, which will always be more efficient than the day system, excepting as before stated, where the workman is a mere attendant to a machine and has no opportunity to make his labor more valuable than a certain fixed amount. The comparative time record will involve the preparation of an order or instruction sheet or slip or tag specifying the distinct operations which must be done. For the sake of uniformity these instructions must be made beforehand, and the workman must not be relied upon to enter them himself, as various workingmen will call the same operation by different names, and will merge certain operations which should be separate into one, or expand one operation into a number. In addition to the definite providing for routing instructions, provision must be made for keeping time on the individual operations. This time-keeping should not be done by the workmen or foremen, but by specially delegated time-keepers, with or without the use of machines designating the time of changing job or the total time elapsed.

375. Comparative Time Records.—To build up a comparative time record, the time-postings will have to be selected and posted on to cards or other form of record, representing the piece worked on, and recording the times required for the same operations by different men.

Figs. 169 and 170 are front and back respectively of an example of a comparative time record.

It is quite apparent that with the accumulation of such data covering performances under a day-work system, covering a period of six months to a year, we have good statistical data to use in connection with time and motion studies to aid in proceeding to the installation of systems resulting in greater economy and higher financial returns to both employer and employee.



COMPARATIVE TIME & COST RECORD

TYPE OF MACHINE ________ PART ________

DRAWING NO. ________ PATTERN NO. ________

OTHER DATA ________

ORDER OF OPERATIONS	DESCRIPTION OF OPERATIONS OR "ROUTING"	MONTH:				MONTH:			
		AVG. TIME	AVG. COST	LOWEST COST	MADE BY	AVG. TIME	AVG. COST	LOWEST COST	MADE BY
1									
2									
3									
4									
5									

COMPARATIVE TIME & COST RECORD

		OPERATIONS						
ORDER NO.	MONTH	FIRST	SECOND	THIRD	FOURTH	FIFTH	SIXTH	TOTALS

FIGS. 169 and 170.—(Fig. 169, top card): Comparative time and cost record, giving the order and time of each operation on a given job. White card, 6 inches wide, 4 inches high. (Fig. 170, bottom, reverse of Fig. 169): The first number (above the diagonal) is the workman's check number, the number below the diagonal is the time. White card, 6 inches wide, 4 inches high.

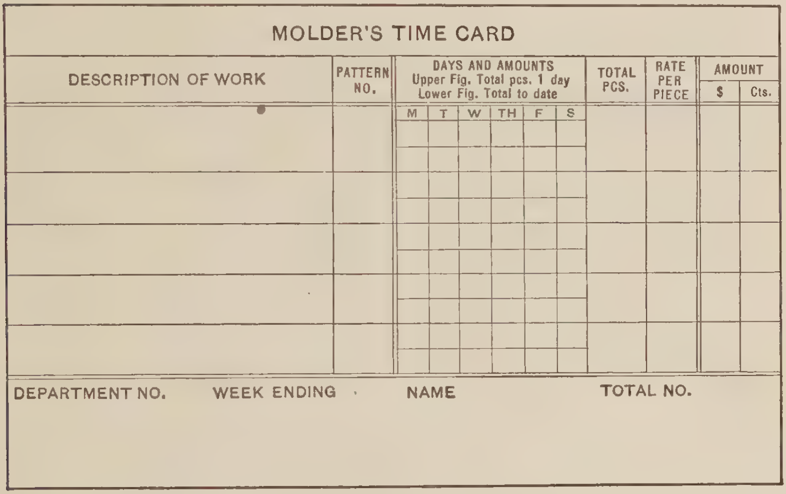
376. Piece-rate System.—The second class of remuneration, namely, piece rate, will always be found most satisfactory where muscular effort predominates, or in work where a low grade of intellect exists. There has been a tendency in many shops to abuse the piece rate with a guaranteed date rate. Under these conditions it might just as well not be used at all, because its very efficacy lies in the penalty to idlers of a low amount of day's earnings for a poor day's work. This is the only remedy for automatically taking care of the time-killer and inefficient workman. A man with a low grade of intellect will, if he has a guaranteed day rate, invariably tend to a very low productive standard. Piece rate is by far the best method of compensating such labor as the simpler classes of molding and foundry work, shoveling coal or dirt, unloading or wheeling pig iron, ore, bricks, etc. In work of this nature there is no danger of the overhead operating expense being unduly increased as the man's productive work increases. Moreover, the man is responsible by the exercise of his own muscles for any increase in his output, and has not to thank any machine for helping him, as is the case with a skilled machinist, who can increase his output by the exercise of a little ingenuity.

Any successful piece-work system will always provide a guarantee to the workman that he will be insured against loss from causes beyond control. This is easily accomplished by the transferring of the worker to a day rate when circumstances warrant it. Such transfer should always be recorded by a transfer ticket, stating the date and time of day the transfer is made, together with the reason for the transfer to day rate. These tickets are collected by the time-keepers and turned over by them to the pay-roll department, where they should not only be kept on file, but should be noted and compared by some person of authority, so as to avoid too free an indulgence in the transfer to day rate.

377. Piece Rates Must Not be Cut.—Piece rates must be carefully and correctly fixed at the outset on a basis of time and motion studies and even if they cause high earnings must not be cut. Cutting piece rates inevitably causes disloyalty and hostility of employees.

378. Differential Piece-rate System.—It is eminently fair that the laborer should be paid not only a straight piece rate, but an increasing piece rate as his output increases. This method of compensation has been designated as the differential piece rate, and has been found very satisfactory. As an example of its operation, a piece rate of 20 cents may be fixed on a certain product, provided the day's output is ten or less. For a day's output of from ten to fifteen pieces, the rate may be made 22 1/2 cents per piece, and for more than fifteen pieces the rate would be 25 cents per piece. At first sight it would appear that the business owner would lose money by paying a higher rate as a man's output increases. This would be the case in such classes of work where general operating expense increases with increase of output. Where the mechanical operating expense does not so increase, it must be remembered that as a man's day's product increases he reduces the ratio between the general overhead of taxes, insurance, officers' salaries, etc., to productive labor cost, and it may be very profitable to use the "differential" piece rate in such cases.

379. Records of Piece-rate Earnings.—The systems required for keeping track of a piece-work pay-roll will involve the registering by means of a time-clock, and a record of pieces of work units accomplished, involving statistical methods practically the same as for time-keeping as indicated in connection with day-work methods. However, it will not be necessary to keep an efficiency record other than the record of piece-rate earnings for this sort of employees, excepting possibly some kind of character record, so as to avoid the attaining of a foothold by an undesirable element.



MOLDER'S TIME CARD

DESCRIPTION OF WORK	PATTERN NO.	DAYS AND AMOUNTS Upper Fig. Total pcs. 1 day Lower Fig. Total to date						TOTAL PCS.	RATE PER PIECE	AMOUNT	
		M	T	W	TH	F	S			$	Cts.

DEPARTMENT NO. WEEK ENDING NAME TOTAL NO.

Fig. 171.—Record of molder's piece work, totals for a week. Salmon-colored card, 7 1/8 inches wide, 5 inches high.

Fig. 171 is a Molder's Piece Rate Time-card, covering half a month.

380. Gain-sharing Methods.—The third general division is that of gain-sharing methods. Gain-sharing, it must be borne in mind, is distinct from a system of dividing indiscriminately among all employees a part of the net profits. The simplest gain-sharing system is one in which a standard of output is established for certain departments, and an amount of money proportionate to the bettering of this standard by any one department is distributed proportionally to each man's wages among all employees in that department. This method is applicable to certain kinds of work where a number of men work jointly in accomplishing a given result and where it is difficult to draw the line as to any one particular employee's accomplishment. A satisfactory application of this system must necessarily involve a consideration of non-productive labor and operating expense as well as increase of output.

381. Premium Wage System.—The best known and most widely used gain-sharing system is the one usually called the "Premium System." Its chief features are the allowing of a definite number of hours to do a certain job, and of any time the workman saves over that, he gets one-half or one-third the benefit.

The name "Premium System" is frequently a bugaboo, and workmen who will refuse to work under it when called "The Premium System" will be successful and content when the same principles are applied and called by such names as "Bonus," "Gain-sharing," "Merit," "Standard Operation Plan," etc. Most manufacturers use the 50 per cent. gain-sharing basis in all cases. It has been objected that under the 50 per cent. scheme the workman gets an inordinately high increase if he reduces the time very largely. For instance, if a man does a ten-hour job in five hours he receives two and a half hours' extra pay, or 50 per cent. increase in wages. If he does the ten-hour job in four hours, he receives one-half of the six-hours' saving, or three hours extra pay or 75 per cent. increase in wages. Conditions in operating of machinery are such that if time standards have been intelligently fixed by observations made by a specialist so as to represent the possible accomplishment of an average workman, the reduction of the time standard by one-half on the part of the average workman is not likely to be possible. Such observational data are not always at hand, however. The term "time standard" or "standard time" is generally used to designate the time in which work should actually be done by a skilled man working as he ought regularly to work, with the correct frequency and length of rest periods so as to avoid fatigue. The term "time limit" is generally used to designate the time allowed in which work must be performed in order to earn premium. It is equal to the "standard time" plus an additional amount called an "incentive."

382. Modifications of Premium System.—Modifications of the premium system have been devised which provide for a higher percentage of bonus or premium wage for small time reductions and a smaller increase of wages for large time reductions. One of these systems pays 10 per cent. increase of wages for a 10 per cent. reduction in time, 15 per cent. increase of wages for 20 per cent. reduction in time, 20 per cent. increase of wages for 30 per cent. reduction in time, etc. The objection to this kind of system is the complication involved in the figuring of the premium payroll. It is easy to find clerks who can figure intelligently on a 50 per cent. basis, but it is hard to get either clerks or workmen to understand more complicated schemes. On the other hand, if the management feels that it is best to introduce as a starter some kind of a premium wage system without the certain knowledge of shortest attainable times which the author recommends as a prerequisite, and which can only be attained by careful observational time-study, then it will be advisable to use some sliding-scale system rather than the so-called straight 50 per cent. gain-sharing method known as the Towne-Halsey system. Where a sliding scale is decided on, it is advisable to tabulate a schedule covering examples of work taking from ten minutes to ten hours with various degrees of time savings and the corresponding premium and total earnings listed which would correspond to various wage rates. This printed schedule should be distributed to all workmen, clerks, and others involved in the system.

The Rowan system is an example of this sliding-scale premium plan. In this system the workman receives as a premium addition to his regular rate the same percentage of his regular rate as the time saved bears to the time allowed, until his hourly rate is doubled, which is the maximum he can earn. To illustrate the Rowan system let L represent the time limit and T the time taken. Then $\left(\frac{L-T}{L}\right)$ is the percentage of the time taken for which the worker is given extra or premium pay.

383. Notices to Employees describing Premium Wage System.—It is desirable to print on the reverse of the report which is to accompany each employee's premium pay an outline of the system. The following is an example of such description:

In order to properly compensate those employees showing the greatest proficiency in turning out good work at the least cost, this Company will hereafter pay in this department, in addition to the regular day rates, amounts as herein specified for all work done in a satisfactory manner within certain time limits. These time limits have been obtained by making careful time and motion studies as well as investigations of the average time in which the work has been done in the past. The time limit in each case is considerably higher than the shortest time in which the work can be well done. As there have been numerous cases in the past in which the work has been done in less time than the time limit, it will not be difficult for proficient men to add to their earnings; the amount of increase depending solely upon individual effort. There is no risk of loss, but every opportunity for gain.

The standard time limit will not be reduced under any circumstances, excepting through the introduction of entirely different methods of doing work, hence there need be no fear of earning too much money. Those who earn the most will be worth the most. The rates per hour at which gains will be figured vary according to the hourly rates of each workman in accordance with the schedule given below:

Hourly rate, cents per hour	Gain-sharing rate, cents per hour
$0.06–$0.07	$0.03
0.08– 0.09	0.04
0.10– 0.11	0.05
0.12– 0.13	0.06
0.14– 0.15	0.07
0.16– 0.17	0.08
0.18– 0.19	0.09
0.20– 0.21	0.10
0.22– 0.23	0.11
0.24– 0.25	0.12
0.26– 0.27	0.13
0.28– 0.29	0.14
0.30– 0.31	0.15
0.32– 0.33	0.16

The conditions governing the payment of gains are as follows:

Gains will not be paid on any work that is not completed to the entire satisfaction of the foreman.

No allowance will be made for bad material or defective workmanship in any previous part of the work, unless the same is pointed out to and endorsed by the foreman as soon as discovered.

All gains will be paid for on the first regular pay day following the completion of the work upon which they are earned.

On account of its being impossible to test certain completed parts immediately, the Company reserves the right to deduct from future pay such gain-sharing pay as may have been advanced on any work that proves defective at final test.

384. Combined Bonus and Premium System.—The danger of workmen's doing the work in too low a time is, however, not the most prevalent difficulty in connection with merit wage systems. The more frequent condition is one of general apathy or indifference to avail themselves of the advantages offered, and to have the time linger within the 10 and 20 per cent. reduction area. In order to overcome this difficulty, some shops where the owners were convinced that the output of certain machine tools could be very much increased found it necessary to put their time limits decidedly below the records of previous accomplishment. A knowledge of the average time of doing work which is the custom in any particular shop is far more prevalent among workingmen than is generally supposed. In some shops, unless a very strong inducement is made, it will be very hard to secure the decided time reductions which are necessary to keep up with modern practice. In such cases it has been found advisable to offer a liberal increase in wages for all work done in less time than the time limit. While engaged in a shop using a method of compensation which paid 10 per cent. for reduction below past average and 20 per cent. for turning work out in the time limit, I found that the method was good only to a certain limit. It did result in a considerable proportion of the men doing the work within the time limits. However, there were no time reductions below these limits even on jobs that covered a period of a number of weeks. This was natural as no further inducement was offered for reduction of time below the time limit, hence I combined with this 20 per cent. bonus scheme the 50 per cent. premium method, offering the men not only a 20 per cent. increase in wages for all jobs successfully completed within the time limit, but an additional gain-sharing premium of 50 per cent. of the time saved below the time limit. For instance, if a man employed at 20 cents an hour brings out successfully in ten hours a job on which the standard time was fixed at 12 hours, he receives 50 per cent. of the saving or 20 cents extra pay, in addition to receiving an increased wage rate of 24 cents an hour for all work successfully done. The offering of this extra inducement could not possibly lead to "fatigue or nervous strain by over-ambitious workers," since the time limits were from 40 to 60 per cent. higher than standard times which in themselves included due additions for correct frequency and length of rest periods.

385. Notices to Employees, Describing Combined Bonus and Premium System.—In order that all employees might fully understand the foregoing plan, a folder containing the following information was printed and distributed:

In order that all employees may be thoroughly familiar with the conditions and rulings in connection with the Standard Operation Plan, the followingout line has been prepared:

1. The 20 Per Cent. Increase for Success

For all jobs successfully completed within the time limit, the Company will pay in addition to the regular hourly wages at which a man is employed, an increase of 20 per cent. over his regular hourly rate. For instance, a man employed at 20 cents an hour will be paid 24 cents an hour for all work successfully done under Standard Operation Plan.

2. The 50 Per Cent. Bonus for Gain

For all jobs successfully completed within less than the time limit, the Company will pay in addition to the 20 per cent. increase as explained in Section 1, a gain-sharing bonus of 50 per cent. of the man's base rate for all time gained. For instance, if a man employed at 20 cents an hour brings out successfully in 10 hours a job on which the time limit is fixed at 12 hours, he receives 50 per cent. of the saving or 20 cents extra pay in addition to receiving 24 cents an hour for all work successfully done under Standard Operation Plan. All those that desire to take advantage of the 50 per cent. or gain-sharing feature of the plan can do so by notification to their foreman.

3. Quality of Work

Work must be completed to entire satisfaction of foreman and inspector. Time is counted for good work only. For instance, if a man has 10 pieces to do and spoils one, the time is counted as applying on 9 pieces finished.

4. Extra Work on Account of Bad Castings

In case a casting shows flaws after machine work is begun, foreman's attention must be called to same at once. If casting is then thrown out, foreman will determine allowance for time spent on same, and will enter allowance on a credit slip, which he gives workman who will hand credit slip to timetaker at his next round. Timetaker will enter credit in "Remarks" column of time sheet. The above applies to any defective material.

5. Extra Time on Account of Breakdowns or Other Unavoidable Causes

Foreman's attention must be called to such time at once and he will determine allowance if any, and hand workman credit slip. Workman will hand timetaker credit slip at his next round, and timetaker will enter credit if any, same to be verified by foreman. Workmen are not permitted to work on machinery repairs excepting those regularly engaged on this work.

6. Several Men Working on Same Standard Operation

Where Standard time work is of such nature that it requires to be participated in by a group of several men, each man's share of the bonus, if any, will be in proportion to the number of hours he has put in on the job.

7. Time Within Which Work Must be Done

Time limits as fixed constitute the limits allowed and work must be done within these time limits if credit is desired for the bonus for success.

8. Unfinished Work

Any man working on a Standard Operation job and not finishing same, will be paid bonus if any, on only the actual number of pieces in the lot on which complete operation has been performed. If operation has been partly completed and the work is finished by some one else, workman starting the job forfeits his bonus, and workman finishing the job will be paid a bonus on same only if job is finished within a reasonable time limit. It will be left to the foreman to determine if this has been done.

9. Difficulties Preventing Success

It is the Company's desire to take every step possible to remove any obstacles standing in the way of accomplishing any job in the time limit. They wish and expect the men to make money out of the Standard Operation Plan. They also wish men and foremen to feel free to make suggestions for improvements which may remove any difficulties in the way of making the stints regularly. Suggestions will be acted upon as promptly as conditions will permit.

10. Permanence of Time Limit

Time Limits once fixed will not be changed excepting on account of changes in design, introduction of new tools, or entirely different methods of doing the work.

11. Payment of Bonus

The payment of bonus is made every week.

386. Bonus System or "Task Work with a Bonus."—Another merit scheme is one known as the daily task bonus system, whose object is to secure the performance of all tasks in any one day within the standards prescribed. It sometimes happens that conditions are such that men will do one job in very good time, and then lose out more on the next job than they gained on the first. This bonus scheme, which was devised to overcome this difficulty, is to pay a fixed amount of money, say 25 or 50 cents every day, as an incentive to a man to do all of his tasks within the standard times set.

387. Individual Job Bonus System.—Some shops have preferred to fix a money price for the accomplishment of certain work rather than a time value. Their reason for this is to prevent certain classes of work costing them too much money, when this work is undertaken by a high-priced man. For instance, if under the premium system a time limit of ten hours were put on a job, and a 30-cent man did the job in six hours, the cost of the work to the company would be six hours at 30 cents plus four hours at 15 cents, or $2.40. On the other hand, if a 25 cents an hour man had accomplished the work in the same time, the cost of the job would have been six hours at 25 cents plus four hours at 12 1/2 cents, or $2. Now the company might find that it could not afford to have this piece of work cost in flat labor more than $2.25. The gain-sharing would be one of money saved the company. This is really a more equitable basis than the hourly plan, inasmuch as the high-priced man has his higher hourly going rate which guarantees his day pay, and he should necessarily have to exert himself more by the use of either his ingenuity or muscles if he expects to get a higher bonus or premium than his fellow craftsman working at a lower hourly rate.

The following tabulation as used by Frederick Parkhurst is an example of a sliding bonus scale.

PRESS 243. ERECT COMPLETE PER MATERIAL LIST L3284. THIS CHART INCLUDES ALL HAND WORK ON ALL THE INDIVIDUAL PIECES

Time each	Bonus each
6.0 hours	$0.40
5.8 hours	0.42
5.6 hours	0.44
5.4 hours	0.46
5.2 hours	0.48
5.0 hours	0.50
4.8 hours	0.52
4.6 hours	0.54
4.4 hours	0.56
4.2 hours	0.58
4.0 hours	0.60

388. Incentives to Securing Continuous Efficiency.—It is quite possible to avoid the troubles of men's doing some jobs in a day quickly, and taking inordinately long times on others, by keeping record of individual workmen's efficiency and by offering rewards for the greatest percentage of individual success to individual workmen. A further inducement will be a prize for greatest collective success by the men in certain departments. Prizes to foremen should be based not only on time reduction, but on ratio of non-productive operating expense to productive, percentage of time and of department pay-roll lost on account of defective workmanship and similar considerations.

Fig. 172 shows a form for Workman's Efficiency and Premium Record under the combined Premium and Bonus system described in paragraphs 384 and 385. This record affords the basis for calculating each man's percentage of success as well as loss and gain percentages. Promotion and extra prizes are awarded to those men showing the greatest continuous efficiency.

WORKMAN'S EFFICIENCY AND PREMIUM RECORD

EMPLOYE NAME *G. I. Stevens* EMPLOYE NUMBER *C 26* DEPT. *Murs* RATE *18*

FORM B 616-5-25-05-2M

WEEK ENDING	TOTAL ON 50		SUCCESS		GAIN		FAILURE		LOSS		BONUS		REMARKS
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	X	X	
June 14/05	45	50	31	10		52	14	40	6	40	2	59	$\frac{\text{Success}}{\text{Total}}$ = 83.7%
21	28	05	22	50		10	5	15	2	45	2	05	$\frac{\text{Gain}}{\text{Total}}$ = 7.8%
28	34	40	34	40	1	47						99	$\frac{\text{Loss}}{\text{Total}}$ = 16.0%
July 5	30	45	28	15	8	14	2	35	1	15			
TOTAL FOR PERIOD	139	20	116	55	11	03	22	30	10	40	5	62	July 15/05
July 12	40	35	37	20	3	27	3	15	1	38			
19	28	05	17	25	3	20	10	40	5	10			$\frac{\text{Success}}{\text{Total}}$ = 76.8%
26	39		23	15		45	15	45	7	50			$\frac{\text{Gain}}{\text{Total}}$ = 8.5%
Aug 2	34	55	31	45	4	47	3	10	1	25			$\frac{\text{Loss}}{\text{Total}}$ = 11.2%
TOTAL FOR PERIOD	142	35	109	45	12	19	32	50	16	03	5	58	
Aug 9	17	10	17	16	3	18							
16	26	06	22	24		12	3	42	2	12			
23	24	35	21	25	1	03	3	10	1	45			
TOTAL FOR PERIOD													

FIG. 172.

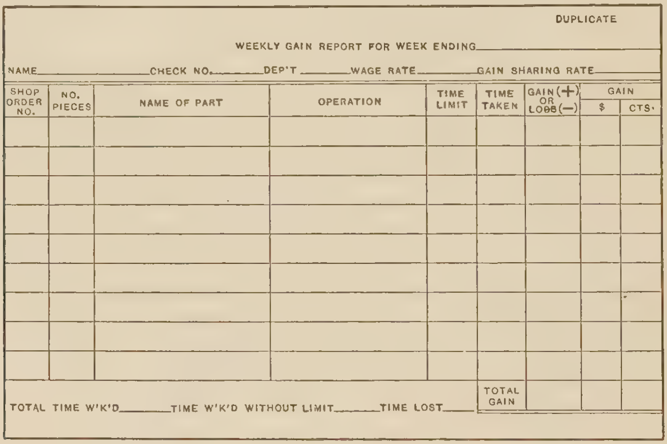
The employee of highest standing under this system would be the man whose percentage would be highest based on the calculation of

$$\frac{\text{Success}}{\text{Total}}+\frac{\text{Gain}}{\text{Total}}-\frac{\text{Loss}}{\text{Total}}$$

Inserting in this formula the figures given in the example in Fig. 172 we have efficiency of G. I. Stevens for period of June 14 to July 5 = 83.7 per cent. + 7.8 per cent. − 16.0 per cent. = 75.5 per cent.; for period July 12 to Aug. 2 = 76.8 per cent. + 8.5 per cent. −11.2 per cent. = 74.1 per cent.

The ten employees showing the highest averages through a period of six months receive an increase of wages of 2 1/2 cents per hour. In addition the highest three men receive cash prizes.

389. Figuring Premium or Bonus Pay Rolls.—The system and statistical methods for a premium or gain-sharing wage scheme involve the same methods as for the day rate, namely, clock record of attendance, time-keeping covering time taken and amount of work done on every operation unit on which a time or money standard is fixed. In addition to the regular pay-roll, there will have to be a system of postings for the premium or bonus pay-roll. The cost-accounting system must also be modified to permit of proper allotment of the bonus money so as to show true cost.



DUPLICATE

WEEKLY GAIN REPORT FOR WEEK ENDING__________

NAME__________ CHECK NO.______ DEP'T ______ WAGE RATE______ GAIN SHARING RATE______

SHOP ORDER NO.	NO. PIECES	NAME OF PART	OPERATION	TIME LIMIT	TIME TAKEN	GAIN (+) OR LOSS (—)	GAIN	
							$	CTS.
					TOTAL GAIN			

TOTAL TIME W'K'D______ TIME W'K'D WITHOUT LIMIT______ TIME LOST______

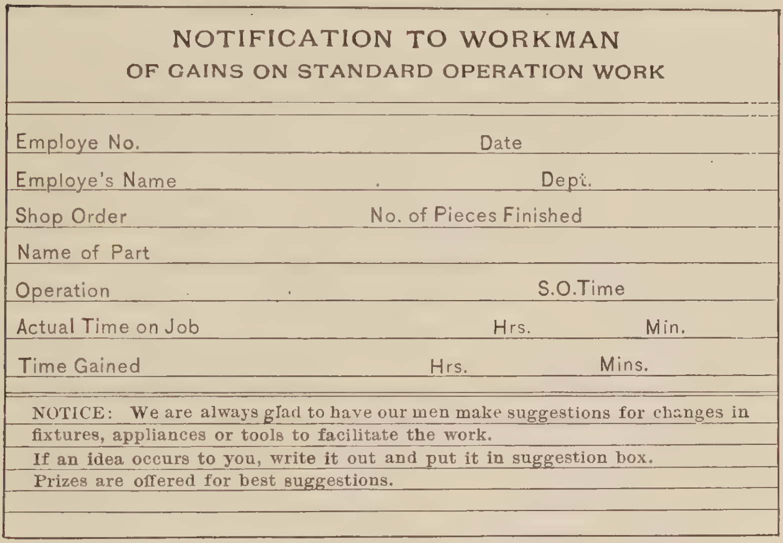
FIG. 173.—A report of the week's gain or loss in time. White card, 6 inches wide, 4 inches high.

The simplest way to take care of a premium or bonus pay-roll is to keep it entirely distinct from the regular pay-roll.

Fig. 172 shows a card form used for collecting the time and figuring the premium pay-roll.

390. Notifications to Workmen of Gains or Losses under Premium or Bonus System.—Fig. 173 shows a form used for collecting these same data on to a weekly slip. The weekly slip is written out in duplicate, one copy going to the man with his envelope of premium money, the other being filed in a loose leaf binder under the man's name, thus forming a record of the man's performances under the system.

With either of the above forms a separate slip, as shown in Fig. 174, is used. This slip serves as a notification and record to the workman which he uses in checking his pay. One or more carbon copies can be made out at the same writing, and can be used as a comparative time record when filed under guides representing parts. This form also serves a useful purpose in filing with regular cost-posting cards, in which time has been figured on the straight wage basis, to show the amount that must be added to individual part costs on account of premium pay. The carbon copies filed by parts are looked over by the time-study and rate-fixing department. If there is a tendency to fail to do the work in the time limit, the workman is helped by demonstration and instruction to do the work in accordance with the instruction card built up from the time study on which the time limit was based.



NOTIFICATION TO WORKMAN
OF GAINS ON STANDARD OPERATION WORK

Employe No. Date
Employe's Name Dept.
Shop Order No. of Pieces Finished
Name of Part
Operation S.O.Time
Actual Time on Job Hrs. Min.
Time Gained Hrs. Mins.

NOTICE: We are always glad to have our men make suggestions for changes in fixtures, appliances or tools to facilitate the work.
If an idea occurs to you, write it out and put it in suggestion box.
Prizes are offered for best suggestions.

FIG. 174.—Workman's notice of gains under premium wage system. Pink bond paper, 6 inches wide, 4 inches high. For failure a similar blue slip is used with the words "Time Lost" instead of "Time Gained."

REFERENCES

GOING: Principles of Industrial Engineering," Chapter VIII.
GANTT: "Work, Wages and Profit," Chapters III to VI inclusive.
CARPENTER: "Profit Making Management," Chapters VIII to XI inclusive.

Emerson: "Efficiency," Chapters VI, IX and X.

Taylor: "Shop Management," Parts 93–201 inclusive.

Gilbreth: "Primer of Scientific Management," Pages 20–30 inclusive.

Ennis: "Works Management," Chapter IV.

Tolman: "Social Engineering."

Schloss: "Methods of Industrial Remuneration."

Taylor: "A Piece Rate System," A. S. M. E. paper, DCXLVII, Vol. XVI.

Halsey: "The Premium Plan," A. S. M. E. paper, CCCCXLIX, Vol. XII.

Towne: "Gain Sharing," A. S. M. E. paper, CCCXLI, Vol. X.

Gantt: "A Bonus System of Rewarding Labor," A. S. M. E. paper, 928, Vol. XXIII.

CHAPTER XXVII

PRINCIPLES UNDERLYING GOOD MANAGEMENT

391. Clear-cut Organization.—The advantages of clear-cut departmental organization have already been set forth. Where each department head and each individual knows his exact duties and the limits of his authority, there will be no trouble due to misunderstanding of these matters. Purely mechanical control through charts and written rules and regulations does not constitute good management. Strength of character, high ethical standards, human sympathy and sound psychologic insight are essential qualities of successful officials.

392. Mutual Confidence and Co-operation.—Mutual confidence is absolutely essential to good management. This requires that officers and department heads must be honest with each other and with their men. One of the results of many years of industrial mismanagement is the attitude of suspicion of many workingmen toward employers and their representatives, whenever there is any change in department heads, methods of manufacture, or system, suspecting that something is going to happen that is detrimental to their interests, and ready to oppose in every concealed manner possible the new official, method, or system. There is only one way to get rid of these difficulties, and that is by actually making the best interests of the workingmen identical with the best interests of the company. To men and managements embittered by long years of hostility engendered by mismanagement such a statement will seem puerile. It needs but a little investigation of the discussions and publications of employers' organizations as carried on to-day, and a comparison of these with similar discussions some ten or fifteen years ago, however, to prove that co-operation is taking the place of warfare to a wonderful extent.

The co-operation must be honest. There must be no wishy-washy namby-pambyism. A lot of rah-rahing at a company baseball game is no sign that employees don't laugh up their sleeves at insincere patronizing.

Frequent changes tend to break down mutual confidence, hence the problem of employment should be handled in a most deliberate and capable manner so as to lessen the need of discharge to a minimum. On the other hand, while the establishment of a permanent force of employees will carry with itself some of the spirit which results in the establishment of mutual confidence, it is necessary, where there is a working force in which there are many old employees, constantly to guard against accepting as correct and unchangeable any long-existing conditions of affairs. Records of what was the best performance in the past must not serve as a guide to what future performances will be, since materials and processes are always changing.

393. Officials to be Relieved of Petty Duties.—There should be some officer in every manufacturing establishment who is free enough from routine duties to permit of his keeping constantly on the alert in the matter of improving the manufactured product, so that the company may always be prepared to make changes at the proper time and keep the product up to date. Manifestly the proper time is not when the shop is crowded with a heavy demand for a current design which is serving its purpose without any complaints from customers and without serious competition. It is always good policy to adhere to established standards as long as the market will permit, unless new standards mean a most decided advantage to the manufacturer. This officer should have charge of the record of all criticisms of product, and should arrange such matters for discussion by salesmen and factory officials who would be affected by changes in design.

In most manufacturing establishments this matter of changes is not handled systematically. On the one hand, slight alterations of no decided selling advantage may mean loss of stock on hand, delays in manufacture, and increased costs. On the other hand, a lack of foresight in anticipating needed changes may result in heavy business losses.

394. Internal Harmony Essential.—In the matter of dealing with men, managing officers should assume always that the best interests of all of the men are identical with those of the management. There should be no attention paid to talks of intrigue or inter-departmental knocking. At the same time the managing officials can easily locate jealousies and unwarranted ambitions on their own initiative if they are capable managers. It may be necessary to have plain talks with department heads who are over-ambitious, and to explain to them wherein their course is in error, or why their ambitions cannot be realized. In some cases it may be best for all concerned if the management can find a better position elsewhere for some department head who is deserving of promotion, but for whom the management can find no promotion in its own organization.

395. A Successful Business the Accumulation of Many Men's Ideas.—It must always be remembered that any successful business represents an accumulation of the ideas of many men. Hence, the endeavor should be to encourage the expressing of ideas for betterment of product, of methods, and of systems, by the rank and file and by the line and staff as well. There is no question but that the committee method tends toward bringing out good ideas. The same is true of good suggestion system with prizes or promotions for men making the best suggestions.

396. Suggestion Systems.—In operating a suggestion system, care should be taken that the committee on awards are thoroughly capable of judging of the merits and demerits of the suggestions they consider. Suggestion systems are usually operated on the basis of an award each month consisting of three or five cash prizes, and mention of the names of others making good suggestions which did not win prizes. Much of the force of a suggestion system is lost if the suggestions for which prizes are given are not put into practice. Annual awards for those suggestions which have resulted in the greatest good during the year, in addition to the monthly awards, will tend to round out the suggestion system to still greater efficiency.

397. Committee Meetings.—The committee method and anything else connected with the shop management should be free of anything savoring of patronizing, hence it is well to avoid calling the committees by fancy names, such as "Council," "Junior Council," etc. A condition of mutual confidence must be established, otherwise the committee meetings will contain men who are silent, being afraid to make criticisms, fearing to incur ill-will or displeasure, or unwilling to make suggestions for improvement for fear of their suggestions being ignored or having their ideas claimed by others.

398. Systematic and Scientific Selection and Placing of Men.—Managing officers and heads of departments should be endeavoring to ascertain the natural aptitude of each individual, and put him into such a department and at such work as he is best fitted for. The most efficient line officers are declared by many successful managers to be men whose characteristics are unswerving devotion to duty and dogged tenacity, rather than men of bright intellect, technical ability, and attractive personality. The last-named qualities are by no means disadvantageous, but they cannot take the place of the first-mentioned ones.

In the matter of appointing department heads and foremen, it should be borne in mind that while a good spirit is engendered by promoting men from the ranks, it is necessary to appoint a certain proportion of men from the outside who have had wider experience than that which can be obtained in any one shop. At the same time, whenever a department head or foreman is taken into the company from outside it must be borne in mind that there is apt to be some one disappointed, whose good-will may be lost, hence an outsider appointed as a department head or foreman needs especially to possess ability to get along with men, and if there is any doubt on this score he should not be appointed, no matter what his technical ability may be. The foreman or department head is always looked upon as the company's direct representative among the men, and the opinion of the men as to the company is based upon their opinion of the foreman or department heads.

399. Justice in Wage Systems.—All systems of piece work, bonus or premium wage, must be just and reasonable. There is hardly any shop where the same system of compensation can be made to apply to all work, and to be able to say that all of the company's work is on piece work or on the bonus system is likely to be nothing at all to brag of. It would be far better to be able to say that all of the work which can be advantageously done on a piece-work or bonus basis is placed on that basis.

In the matter of wage systems, much trouble can be forestalled by making it a rule that a certain piece rate, premium, or bonus time is established for each separate machine and process, and have this most distinctly understood and specified. By distinctly specifying that a certain premium, bonus or piece rate applies to machine No. so and so and only to machines of the same type, style and condition, and driven in the same manner, there can be possible complaint if the rate is changed, as it should be, if a different type of machine is installed or machinery is driven in a different way. There can be only one rational basis for piece, premium, or bonus times, and that is an absolutely certain knowledge of conditions currently existing and applying to each separate machine or method. Men experienced at rate-fixing can establish many such time standards from the records of observations on similar work. However, the utmost caution should be observed in establishing standards without demonstrations, since nothing establishes confidence in the ability and justice of the management in a more satisfactory way than time standards, which are neither too low nor too high, but are eminently correct at their first announcement. An expert machine operator usually makes a poorer job of establishing time standards than a technically educated man used to taking and recording observational data. On the other hand, if the expert machine operator or expert mechanic in other lines be used as demonstrator, and a man skilled at accurate observational records be assigned to do the timing, the results are far more likely to be satisfactory. It is impossible to secure a man who is an expert operator on all kinds of machinery, and it is utter folly to hire as a speed boss, or rate fixer, a man who claims to be such a prodigy. A man experienced at time-study work, using such mechanics for demonstrators as each department can furnish, these mechanics receiving extra pay while on demonstration work, will secure correct time standards. If the time-study man claims to be a universal expert on all kinds of machinery, he may at once be set down as a quack and a man who will cause more friction than good.

400. Sufficient Clerical Force.—Sufficient clerical force to get out all of the needed records and departmental reports does not necessarily mean many non-producers. The only use of records and departmental reports is as an incentive to action. There is absolutely no use of a transfer clerk or good tracing records if the shop superintendent or general foremen do not make use of these records. The same is true of all reports having to do with cost-analysis and comparative inventories. Certain definite times should be set aside for meetings to discuss all such reports, and it should always be borne in mind that the object of such meetings is to find out what conditions are revealed by the reports based upon records, and what actions should be taken as a result of the revealing of these conditions.

401. Apprenticeship Systems.—I come now to the most important as well as the most neglected of all opportunities in connection with good management, namely, the apprenticeship system.

There is no gainsaying the fact that the manufacturing trades do not get their fair percentage of bright, ambitious, and serious-minded boys. The reason for this is that the boys are neglected, and far too often have to work in unsanitary and unnecessarily dirty surroundings, so that the most self-respecting are attracted by opportunities to enter mercantile pursuits whose managers seem to give more attention to the selection and developing of boys they hire than is the case with manufacturers.

Each apprentice should have a certain course laid out, at least tentatively, when he starts in. This course need not and cannot be the same for each apprentice. In fact, it will probably have to be varied from time to time during his apprenticeship as close attention to him and his work reveals what are his best aptitudes. The old catch phrase, "We aren't running an educational institution," which is told the apprentice boy all too often, will have to be retired if manufacturers want good apprentices, for that is exactly what they will have to make of their apprenticeship system—an "educational institution." The boy cannot be taught too much about the business during his apprenticeship years, and the teachers cannot be any too good. Talks during working hours by the very best men in each department, with demonstrations, as well as individual instruction, will result in advantage to the employer who uses such systems.

402. Industrial and Vocational Education-Continuation Schools.—There is much talk nowadays of extension work in the way of the higher technical state institutions reaching out into the industries and teaching the employees, and of continuation schools in which the students who have had only six or seven years of public school life are given the benefits of further training as part of the regular public common-school system. The sooner this talk materializes into actual accomplishment the better, since such work will result not only in better intelligence among the workers, but in better habits and cleaner manhood. An employer can well afford to allow his apprentices to have an hour a day on pay to attend continuation school for the sake of making them better citizens, and he can afford to add to this hour another hour of technical instruction during the daytime. Whether this technical instruction is a sort that can be given in extension work by a state technical institution, or whether it must be so specialized that it will require a teacher from the staff of the company itself, will depend wholly on the nature of the industry. Naturally it would be cheaper, where the number of apprentices are limited, and the technical branches are such as can be taught in general classes, to allow the students to attend extension classes, supported by either state, municipal, or employers' association funds, than to attempt to run a private school.

The day schools have been found to accomplish definite results in a far better manner than night schools. When the school session is in the day, the boy can prepare his work at night, whereas with night school he has no time for such preparation.

To a lesser extent the neglect of the apprentice boy has its parallel in the neglect of the technical school and college graduate in special apprenticeship courses. A few of the larger electrical corporations are doing excellent work in giving systematic instruction to this class of apprentices, with excellent results in their own favor, and their example could well be followed quite generally.

403. Bureaus of Vocational Guidance.—A number of our large cities have begun to establish bureaus of vocational guidance whose purpose is to gather scientific data on the qualifications of individuals best fitted for certain occupations, and of the occupations best fitted to individuals showing certain physical and psychological combinations. Such bureaus should be under the leadership of men with industrial experience, liberal education, and broad human interests. In the large cities the directors of such bureaus should be provided with capable specialists as assistants to conduct the psychologic and medical examinations, prepare the economic and statistical records, and conduct the clerical work. In the smaller industrial centers, the superintendent of schools should be aided by specialists from the state colleges and universities assigned to such extension work, in starting proper systems of vocational guidance.

404. Educational Activities must not be Hampered by Factional Influence brought to bear by Organized Business or Organized Labor.—H. L. Gantt states that "Our difficulty has been mainly with the commercial man, who often seems incapable of considering anybody's interest except his own, and has not yet recognized that the prosperity of all is directly helped by the prosperity of each. As yet he has no idea of what real co-operation means. His idea of co-operation is that of the pack or the herd, whose co-operation is for attack or defense. Certain well-known leaders of manufacturing and labor organizations respectively are prominent public advocates of this kind of co-operation, which aims to despoil the outsiders for the benefit of those in the ring." Those leaders in industrial education who are earnestly striving for the benefit of all, are seriously handicapped by the activities of the representatives of labor and employers' organizations on the one hand and the old-school advocates of education for culture only on the other. The employer frequently wishes industrial and vocational education to be an immediate tool for breaking up trades unionism, and will lobby strongly for men who are in sympathy with this attitude. The labor union leader frequently will oppose in educational work any man who has been identified with scientific management or efficiency movements, and will oppose any system of industrial education which in his opinion aims to give training which should be given by members of the trade to a limited number of apprentices. The classicist demands cultural subjects first and will not recognize culture in most modern practical industrial and vocational training. Between these three mutually opposing influences the educator who is timid and under-paid and afraid of arousing hostile influences, is frequently in a dilemma in which he needs the support of civic organizations which are thoroughly non-partisan.

405. Some Examples of Good Apprenticeship Systems.—The Baldwin Locomotive Works have conducted three distinct classes of apprentices for a number of years, and as their system has been eminently successful an outline of it is appended:

BALDWIN LOCOMOTIVE WORKS

BURNHAM, WILLIAMS & CO.

PHILADELPHIA

Apprenticeship System

In recent years manufacturing has tended so largely toward specialization that young men apprenticed to mechanical trades have been able in most cases only to learn single processes, and, as a result, the general mechanic has threatened to become practically extinct, to the detriment of manufacturing interests generally. In view of this fact the Baldwin Locomotive Works have established a system of apprenticeship on a basis adapted to existing social and business conditions.

Apprentices are taken in three classes, as follows:

Apprentices of the First Class

The first class will include boys seventeen years of age, who have had a good common-school education, and who will bind themselves by indentures (with the consent of a parent or guardian in each case) to serve for four years; to be regular at their work; to obey all orders given them by the foreman or others in authority; to recognize the supervision of the firm over their conduct out of the shop as well as in it; and to attend such night schools during the first three years of their apprenticeship as will teach them, in the first year, elementary algebra and geometry; and in the remaining two years, the rudiments of mechanical drawing.

Apprentices of the Second Class

The second-class indenture is similar to that of the first class, except that the apprentice must have had an advanced grammar-school or high-school training, including the mathematical courses usual in such schools. He must bind himself to serve for three years, and to attend night schools for the study of mechanical drawing at least two years, unless he has already sufficiently acquired the art.

Apprentices of the Third Class

The third-class indenture is in the form of an agreement made with persons twenty-one years of age or over, who are graduates of colleges, technical schools, or scientific institutions, having taken courses covering the higher mathematics and the natural sciences, and who desire to secure instruction in practical shop work.

The indentures or agreement in each case place upon the firm the obligation to teach the apprentice his art thoroughly and to furnish him abundant opportunity to acquire a practical knowledge of mechanical business. The firm is also bound to retain the apprentice in service until he has completed the term provided for in the indenture or agreement, provided his services and conduct are satisfactory. In all cases the firm reserves the right to dismiss the apprentice for cause.

The rates of pay in the different classes are as follows:

	First year per hour	Second year per hour	Third year per hour	Fourth year per hour
Apprentices of the First Class......	5 cents	7 cents	9 cents	11 cents
Apprentices of the Second Class....	7 cents	9 cents	11 cents	

Apprentices of the Third Class, first 6 months of first year, 13 cents per hour.
Apprentices of the Third Class, second 6 months of first year, 16 cents per hour.
Apprentices of the Third Class, first 6 months of second year, 18 cents per hour.
Apprentices of the Third Class, second 6 months of second year, 20 cents per hour.

In addition to the rates mentioned above, apprentices of the first class each receive an additional sum of $125, and apprentices of the second class an additional sum of $100, at the expiration of their full term of apprenticeship respectively.

By the course of training provided for in this system it is believed that a great benefit will accrue to the mechanic as well as to the employer. To young men who have received a thorough technical education, the two years' course in shop work is especially recommended.

Further particulars will be given on application.

The Westinghouse industries in the vicinity of East Pittsburg have carried on extension and continuation work to a considerable extent. Following is an outline of their work which was given by Mr. C. R. Dooley (who is in charge of the educational division of the apprenticeship department of the Westinghouse Electric and Manufacturing Company), in a paper read before the American Institute of Electrical Engineers in June, 1909:

The educational activities in the vicinity of the Westinghouse interests at East Pittsburg divide themselves into two general classes: 1. The training of the graduates of engineering schools. 2. The training of non-technical men. The training of non-technical men is further divided into two distinct lines: 1. The apprenticeship system, which includes a certain amount of systematic class instruction given during working hours. 2. The night school, where attendance is purely voluntary. Both of these have a place in the training of non-technical men.

The Apprenticeship System.—In the shop a certain section is devoted to the apprentices. This section is fitted with a complete equipment to furnish shop practice in all branches of the machinists' trade. The boys are under the guidance of all-around mechanics taken from the shop organization and chosen for their interest in young men as well as for their skill as workmen. The boys remain in this section approximately two years. The latter half of their course is spent in the various sections of the shop.

The class-room instruction is provided on the company's time, and is conducted throughout the four years of the course. Special rooms inside the works have been fitted up with suitable tables, desks, blackboards, etc., much the same as in an ordinary schoolroom. The atmosphere is hardly that of a school, but rather that of a class where the boys are given problems and explanations concerning the things with which they work every day, instead of problems in abstract mathematics. In connection with the character of the class work, there are three vital points: 1. The scientific principles underlying the subjects must be taught. 2. The scientific principles can best be presented through the working of practical problems dealing with the things of the boy's every-day life. 3. The same problem must teach him certain facts and specific knowledge concerning the things with which he is working, such as weights, costs, and strength of materials, gear speeds, pulley and belt speeds, etc. In fact, a knowledge of the things with which the problems deal and the facility afforded for thinking about these very ordinary things may be the most valuable feature of this instruction.

There is another phase of the work without which all else will fail. For want of a better name, we call it spirit. It includes loyalty and enthusiasm, not only in the work and the future it holds for the boys, but also in all their daily relations with their fellows—a spirit of service and willingness, confidence in all things and all people, and eternal optimism.

The Technical Night School.—Some years ago a technical night school was started in the vicinity of the manufacturing interests at East Pittsburg. Its management is independent of any commercial industry, though its activity is encouraged and fostered by the local organizations, including the public school board, the latter furnishing the building. In the beginning there were half a dozen teachers and a few dozen students who attended classes in drawing, elementary mathematics, and shop practice. At present there is offered an opportunity for systematic study in such fundamentals as mathematics, mechanical drawing, mechanics, physics, theoretical and applied electricity, chemistry, shop practice in both wood and metal, theoretical and applied steam engineering, etc. There is a faculty of twenty-five instructors and an enrolment of about three hundred students. The instructors are not only versed in the theory of their respective subjects, but each is also actively engaged during the day with his subject within the organization of a commercial factory. The opportunities for obtaining exceptionally trained teachers are therefore ideal.

Attendance is voluntary, and a small tuition fee is charged. Admission is extended to all, regardless of occupation or previous education. The low educational entrance qualifications are cared for by a preparatory department. Practically all of the students are employed in the various shops in this vicinity. Of the forty-five men who have been graduated during the past three years, practically all have been steadily advanced in position and reponsibility, and forty are still with their original employers. Some of the students are doing high-grade engineering work in the engineering department and in the drafting office of the nearby electrical manufacturing company. Others are successful salesmen and many are doing responsible work in the erection department and in the shop organization.

The engineering night school has a large field of activity. At the start its students have a clear idea of commercial practice such as is seldom possessed by the newly graduated college student. This early experience instils an appreciation of the value of time and of scientific training that tends to produce the most efficient student. They have learned several years earlier in life than the college student that scientific study and commercial practice not only go hand in hand, but that they should continue hand in hand throughout life, if the highest achievements are to be attained; that there never comes a time when the one can be laid aside and the other taken up. They also know the importance of the routine of life, that from the office boy to the president, it is the fellow who gets the job done that gets the bigger job to do.

406. Co-operative Schools.—An account of educational activities engaged in by manufacturers would be incomplete without mention being made of the co-operative work first initiated by the University of Cincinnati under the direction of Dean Hermann Schneider. In this plan students prepared to enter the university are taken into the machine shops by the owners of the shops. The students spend alternate weeks in the shops and alternate weeks in the university. While in the shops they are visited by university instructors designated as co-ordinators, who note what they are working on, how they are doing it, and any other points of educational value in their surroundings, and discuss them in a class devoted to this purpose during the week that they are attending the university. The course covers five years, eleven months of each year being put in during alternate weeks at the university, the remainder of the time being in the shops as regular workmen. The employers are thoroughly satisfied with the plan and state that it develops men who do not have the handicap of inability to conform to shop discipline, and ignorance of shop methods, which characterized a considerable percentage of their university graduate apprentices formerly. The plan has also been adopted at the Fitchburg, Mass., and York, Pa. high schools and at the Lewis Institute of Technology in Chicago in co-operation with members of the National Metal Trades Association.

407. Employment of Industrial Engineers in an Advisory Capacity.—It must be quite apparent to the progressive manufacturer who has followed the development of industrial engineering and scientific management, that most of the work of factory planning, equipping and organizing requires exceptional experience and training. Most ability of this sort is one-man ability and cannot be syndicated. As soon as we have expert service of this sort take the corporate form with a large force of assistants, it means that the service is of the mimeographed, ready-made, correspondence-school standard. The personal services of a well-educated well-trained mature expert at $100 a day and upward plus traveling expenses are frequently cheaper in the long run than syndicated expert services at lower prices.

REFERENCES

Brisco: "Economics of Business," Chapter IV.

Dodge: "The Spirit in Which Scientific Management Should be Approached," Tuck School Conference Report.

Carpenter: "Profit-making Management," Chapter XIV.

Redfield: "The New Industrial Day," Chapters VI–X.

Lodge: "Rules of Management."

Gantt: "Work, Wages and Profits," Chapter IX.

Carlton: "Education and Industrial Evolution," Chapters I–IV and VII–XII inclusive.

Day: "Industrial Plants," Chapter XII.

CHAPTER XXVIII

A BIBLIOGRAPHY OF WORKS MANAGEMENT

408. Reading and Study Necessary for the Man Who Aspires to Success in Business Administration and Industrial Management.—The application of scientific methods to the investigation of problems of factory management has resulted in the accumulation of a bibliography of considerable extent having to do wholly with these questions. Fundamental prerequisites or accompaniments to the study of such a bibliography are the three branches of learning in which he who would train himself for the profession of works management should be thoroughly grounded, namely, engineering, industrial economics and industrial psychology. It is noteworthy that the authors of the works hereafter referred to have been, almost without exception, engineers, who have added to their technical training and experience the essential knowledge of accounting, psychology, and economics, requisite to a comprehensive grasp of the problems of factory management.

The ambitious engine tender has at hand several works of more or less merit on the steam-engine. He is a subscriber to some technical or trade paper from which he gains advice and inspiration. The same is true of the first-class pattern-maker and draftsman, and of any high-grade craftsman. The chief engineer and the master mechanic of a large industrial establishment usually have at hand a supply of high-class works of reference. It seems singular that the same should not be true of commercial managers, or of engineers who have been drawn into positions of works management. To be sure, the literature of factory economics is not abundant. Yet there have been some very good works published. A reading knowledge of some of these works would be of great value to managers and their assistants in charge of departments. Such a knowledge might often result in the anticipation of plans and methods which would otherwise require years to mature. That this is true is evidenced by the frequent reproduction, in the most elementary form, of methods thought new and original by those introducing them, when in fact the same methods have been far more completely worked out by others. A similar ignorance of current practice and of best methods on the part of the mechanical and engineering department heads would be considered unpardonable.

409. A Business or Shop Library for Managers and Employees.—A certain evidence of the lack of reading along these lines by those who might profit therefrom is the ease with which an unscrupulous man who has made himself familiar with the literature of works management is able to palm off, as originated by himself, charts, tables, and forms, and sometimes pages of discussion, copied verbatim from standard works. It certainly would be a profitable investment for many a manufacturing corporation to provide a reference library of such standard works as would be of particular application to and bear upon the business concerned, and to encourage the employees to make use of this reference library in working hours for reference, and out of working hours for education.

A. S. M. E. Papers.—There are certain papers presented before the American Society of Mechanical Engineers which may justly be termed classics in industrial management. Most of these have been reprinted by the society and can be purchased in pamphlet form. The entire series should be bound together into a single volume for convenience in handling and to prevent wear and tear. These papers are as follows:

Vol. X, Paper No. CCCXLI.—"Gain Sharing," a paper by Henry R. Towne, presented at the May, 1889, meeting of the American Society of Mechanical Engineers.

This paper, and several others, will be listed among the books reviewed, since these papers well deserve the name of classics.

"Webster defines profit as excess of value over cost, and gain as that which is obtained as an advantage. I have availed of this well-expressed though delicate distinction between the two terms, to coin a name for the system herein described, whereby to differentiate it from profit-sharing as ordinarily understood and practised. The right solution of this problem will manifestly consist in allotting to each member of the organization an interest in that portion of the profit fund which is or may be affected by his individual efforts or skill, and in protecting this interest against diminution resulting from the errors of others or other extraneous causes not under his control. Such a solution, while not simple, is attainable under many circumstances, and attainable by methods which experience has shown to be both practical and successful."

The plan advocated by Mr. Towne is the differentiating of all items affecting cost of production over which the operatives have any control whatever, and offering the operatives a share, say one-half, of any reduction per unit of product that they may be able to bring about in these items in the course of a year. Foremen and other responsible heads are to receive a larger pro-rata share of the saving effected than the rank and file.

Mr. Towne presents tables showing the operation of the system for two years at the Yale and Towne Works. It is interesting to note that the company has discontinued the plan.

The discussion by Mr. E. F. C. Davis is the first record published of the so-called premium plan. He cites an instance of a friend of his who announced to his workmen that he would allow a definite number of hours to do a certain machine-shop job, and that of any time the workman saved over that he would get one-half the benefit. Mr. Davis stated that after the workmen found that the offer was really made in good faith, the plan worked very well.

Vol. XVI, Paper No. DCXLVII.—"A Piece-rate System," by Fred W. Taylor, a paper presented at the June, 1895, meeting of the American Society of Mechanical Engineers.

In this paper, Mr. Taylor presents the first recorded recommendations in favor of a careful or scientific study of the subject of rate-fixing, and of the differential piece rate. Piece-work prices based on elementary rate-fixing differ from such prices as usually made, in that a careful study is made of the elemental times required to do each of the constituent steps into which the manufacturing operations of an establishment may be analyzed. These elementary operations are then classified, recorded, and indexed, and when a piece-work price is wanted for work, the job is first divided into its elementary operations, and the total time for the job is summed up from these elementary data.

The differential-rate system of piece work consists of the offering of two different rates for the same job—a high price per piece in case the work is finished in the shortest possible time and in perfect condition, and a lower price per piece if it takes a longer time to do the job, or if there are any imperfections in the work.

Mr. Taylor expresses it as his opinion, based on extensive experience, that the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent larger return for their time than they have been receiving, and that employers can well afford to pay higher wages per piece, even permanently, provided each man and machine in the establishment turns out a proportionately larger amount of work.

The most formidable obstacle to the solution of the piecework problem, Mr. Taylor states, is the lack of knowledge of the quickest time in which each piece of work can be done, the remedy for this lying in the establishment in every factory of a proper rate-fixing department.

In closing the discussion of his paper, Mr. Taylor expressed regret that the elementary rate-fixing features of the system he described did not receive more attention by the members discussing his paper, and stated it as his firm conviction that this question must occupy more and more of the attention of manufacturers in the future.

This paper of Mr. Taylor's, together with his later and exhaustive one delivered at the June, 1903, meeting (an abstract of which is given in this bibliography), deserve the most careful perusal of every manufacturer.

Vol. XXIII, Paper No. 928.—"*A Bonus System of Rewarding Labor,*" a paper by H. L. Gantt, presented at the December, 1901, meeting of the American Society of Mechanical Engineers.

The paper is a description of a system introduced by the author into the machine shop of the Bethlehem Steel Company. An instruction card is made out, showing in detail the best method (so far as knowledge and experience available can give it) of performing each of the elementary operations on any piece of work, specifying the tools to be used, and setting the time needed for each of these operations as determined by experiments. The sum of these times is the total time needed to complete the piece of work. If the workman accomplishes all the work assigned in any one day within the total time limits specified, he is paid a definite fixed bonus, in addition to the day rate which he always gets. If he fails, he gets simply his day rate. As the time for each detail operation is specified on the instruction card, the workman can see continually whether he is going to earn his bonus or not. If he finds any operation which cannot be done in the time specified, he must at once report it to his foreman. If, on careful investigation by the man making out the card, the workman's statement is found to be correct, a new instruction card is made out, explaining the proper method of working, and allowing the proper time

The foremen also receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all of their men earn bonuses.

> "As the instruction cards are made out by a skilful man, with the records at hand, they invariably prescribe a better method for doing the work than the ordinary workman or foreman could devise on the spur of the moment. . . .
>
> "The system has many of the advantages of the differential piece-work method, by which the compensation is quite large for the maximum amount of work obtainable. Since it is impossible for men to earn bonuses when their machines are out of order, an automatic punishment is provided for breakdowns. . . .
>
> "Considerable training is necessary to teach the men, who, as a rule, are ordinary laborers, to follow the instruction cards. Having once given them this training, however, the advantage of having a first-class machinist to do the thinking, and to use for them the best results already obtained, produces an efficiency which would be absolutely impossible if the workmen were left to themselves."

Samples of the forms used are given, as filled out in actual use. The author states:

> "If we have a thorough knowledge of all the conditions, and are able to introduce piece work, it is undoubtedly to be preferred. But we must remember that aside from the great injustice of it, there is nothing so demoralizing as cutting piece rates."

The bonus system carries with it the advantage that if the time allowance is too easily reached, a limit is nevertheless set to any workman's daily gain, which can never be more than the fixed daily bonus.

Vol. XXIV, Paper No. 1003.—"*Shop Management,*" by Fred W. Taylor, a paper presented at the June, 1903, meeting of the American Society of Mechanical Engineers.

This exhaustive paper, which covers 150 pages of the society's transactions, is a record of some twenty years of genuine research work by the author. The compiler of this bibliography emphatically agrees with Mr. Henry R. Towne in his characterization of this paper as the most valuable contribution to this subject which has yet been made. As stated by Mr. Towne, it includes so complete a review as to constitute almost a history. It is clear-cut and comprehensive, written in a characteristic, vigorous, clear style.

Mr. Taylor brings out again, and in greater detail than in his former paper of 1895, the importance of scientific time study as the foundation of the best management. In addition to the more detailed description of scientific rate-fixing, the other new features not brought out in his previous paper referred to are the use of the "Instruction Card" to accompany any system of compensation, whether it be Mr. Gantt's bonus, Mr. Taylor's differential piece rate, the premium method, or ordinary piece rate; also the system of functional foremanship.

Functional management consists in so dividing the work of management that each man, from the assistant superintendent down, shall have as few functions as possible to perform. If practicable, the work of each man in the management should be confined to the performance of a single leading function. As example of this fuctional management, there are suggested in the factory office, the man in charge of order of work and routing department, the one in charge of instruction-card department, the time and cost clerk, and the shop disciplinarian, these four divisions making up what Mr. Taylor calls the "planning department." In the shop itself the functional foremanships are those of "gang boss," who has charge of the preparation of all work up to the time the piece is set in the machine, including the selection and providing of jigs, templates, drawings, etc.; the "speed boss," who must see that the proper cutting tools are used, that the cuts are started right, and that the best speeds and feeds are employed; the "inspector," who is responsible for the quality of the work; and the "repair boss," who sees that each machine is kept clean by its operator and free from rust and scratches, and that it is oiled and otherwise properly treated.

Vol. XXV, Paper No. 1010.—"*Slide Rules for the Machine Shop*," by Carl G. Barth, a paper presented at the Dec. 1903 meeting of the American Society of Mechanical Engineers. In this paper Mr. Barth describes the methods to be undertaken in securing correct feeds and speeds and other matters connected with the machine tool equipment of a metal-working industry. He also outlines the mathematical theory on which he bases the construction of his slide rules by the use of which an experienced machine-tool operator with mental capacity to understand the slide rule, or a technically trained man preparing instruction cards, can determine the correct gear and pulley combination to use in machining a given piece.

Vol. XXVII Index.—At the close of the 1906 volume there is an index of all papers on Works Management and discussions in the transactions of the society up to that date. This index includes reference to several discussions not here mentioned.

Vol. XXVIII, Paper No. 1119.—"*The Art of Cutting Metals,*" by Fred W. Taylor. This paper should be read and reread by every foreman, manager, or proprietor of an industry using machine tools, as well as by any person proposing to undertake the fixing of time standards or wage rates on machine tool work. It is a monumental piece of research work that has seldom been equalled even in the field of pure science. The paper is illustrated by a large number of charts, tables and photographs illustrating proper cutting angles, feeds and speeds, lubrication, etc.

Vol. XXXIV, Paper No. 1378.—*Report of Sub-committee on Administration on the Present Status of the Art of Industrial Management,* presented at the December, 1912, meeting of the Society. The report of the committee itself is excellent and indicates marked progress toward the formulating of definite principles of the Science of Management. Unfortunately a good deal of the discussion does not directly bear on the report of the committee but is a repetition of matter already presented to the public by the speakers.

410. A Bibliography of the Classical or Pioneer Literature of Works Management or Industrial Engineering prior to 1904.—In the Engineering Magazine, Vol. XXVII, No. 4, July, 1904, the author of this text reviewed the bound volumes and A. S. M. E. papers published up to that time. This bibliography included a number of volumes not mentioned in the present edition of this work, as they are not representative of present-day practice. However to the man interested in the historical development of the subject the list given will be of interest. In the same number of the Engineering Magazine immediately following the paper just referred to, is a complete bibliography of the periodical literature of Industrial Engineering up to and including May, 1904.

411. A Standard Reference Library of Industrial Management and Industrial Engineering.—The following list is intended to include such works as the progressive industrial corporation should possess and encourage its employees to read:

Alexander Hamilton Institute: "Organization and Management," by Lee Galloway.
Bentley: "Corporate Finance and Accounting."
Brisco: "Economics of Business."
Bunnell: "Cost Keeping for Manufacturing Plants."
Carlton: "Education and Industrial Evolution."
Carpenter: "Profit-making Management."
Church: "Expense Burden."
Church: "Production Factors in Cost Accounting and Works Management."
Cook: "Factory Management."
Conyngton: "The Modern Corporation."
Day: "Industrial Plants."
Day: "Accounting Practice."
Diemer: "Factory Organization and Administration."
Emerson: "Efficiency."
Emerson: "Twelve Principles of Efficiency."
Ennis: "Works Management."
Evans: "Cost Keeping and Scientific Management."
Gantt: "Work, Wages and Profit."
Gilbreth: "Primer of Scientific Management."
Gilbreth: "Motion Study."
Goddard: "The Binet-Simon Measuring Scale for Intelligence."
Going: "Principles of Industrial Engineering."
Going: "Methods of the Santa Fe."
Hartness: "The Human Factor in Works Management."
Humphreys: "Lecture Notes on Business Engineering."
Jacobs: "Betterment Briefs."
Knoeppel: "Maximum Production."
LaSalle Extension University: "Business Organization."
Lodge: "Shop Rules."
Lough: "Corporation Finance."
Muensterberg: "Psychology and Industrial Efficiency."
Nicholson: "Factory Organization and Costs."
Parkhurst: "Applied Methods of Scientific Management."
Perrigo: "Modern Machine-shop Construction, Equipment and Management."
Redfield: "The New Industrial Day."
Ruger: "The Psychology of Efficiency."
Schloss: "Methods of Industrial Remuneration."
Schneider: "Specifications for Buildings."
Scott: "Increasing Human Efficiency in Business."
Sullivan; "American Corporations.
Taylor: "Shop Management."
Taylor: "The Art of Cutting Metals."
Tolman: "Social Engineering."

TUCK SCHOOL: "Conference on Scientific Management."
TYRRELL: "Engineering of Shops and Factories."
WEBNER: "Factory Costs."

The above list includes most of the works mentioned as supplementary reading to the various chapters of this work and represent an up-to-date private or company library.

421. A Comprehensive Library of Supplementary Reading for a School of Engineering or School of Business Administration or Public Library.—The following list is in addition to the aforementioned works:

Accounting and Cost-keeping.

COLE: "Accounts."
HATFIELD: "Modern Accounting."
RIDGWAY: "Cost Accounts."
ARNOLD: "The Complete Cost Keeper."
ARNOLD: "The Factory Manager and Accountant."
BENTLEY: "The Science of Accounts."
BEST: "The Cost Accounts of an Engineer and Iron Founder."
GARCKE AND FELLS: "Factory Accounts."
MILLENER: "Cost Accounts."
PEARN: "Workshop Costs for Engineers and Manufacturers."
SPRAGUE: "The Philosophy of Accounts."
LISLE: "Accounting in Theory and Practice."
DICKSEE: "Advanced Accounting."
KEISTER: "Corporation Accounting and Auditing."
MOORE AND MINER: "Accounting and Business Practice."
SOULE: "New Science and Practice of Accounts."
MACKENZIE ST. CLAIR: "The Modern Balance Sheet."
Tipson: "The Theory of Accounts."
"The Accountant's Library." Published by Gee & Sons, London.
"Cyclopedia of Accounting." 8 Volumes. Published by W. Green & Sons, London.
BROWN: "History of Accounting and Accountants."
"The Accountant's Manual." Published by Gee & Sons, London.
DAWSON: "The Accountant's Compendium."
RENN: "Practical Auditing."
J. H. Goodwin: "Bookkeeping and Business Manual."

Business and Engineering Law.

BURDICK: "Essentials of Business Law."
PARSONS: "Laws of Business."
WAIT: "Law of Operations Preliminary to Construction."
BALL: "The Law Affecting Engineers."
HARING: "Engineering Law."
JOHNSON: "Contracts and Specifications."
BRENNAN: "Handbook of Commercial Law."
SPENCER: "Commercial Law."

SULLIVAN: "American Business Law."
TUCKER: "Contracts in Engineering."

Commercial Geography.

ADAMS: "Commercial Geography."
CHESHOLM: "Commercial Geography."
GREGORY: "Physical and Commercial Geography."
MACFARLANE: "Commercial and Industrial Geography."
MORRIS: "Industrial and Commercial Geography."
TROTTER: "The Geography of Commerce."

Economics of Workingmen.

GUNTON: "Wealth and Progress."
UNION: "Labor Legislation, Labor Movements and Labor Leaders."
MARX: "Wage Labor and Capital."
PETERS: "Labor and Capital."
RIIS: "How the Other Half Lives."
ROBERTSON: "The Eight Hours Question."
SCHOENHOF: "The Economy of High Wages."
SHADWELL: "Industrial Efficiency."
SPAHR: "America's Working People."
HOBSON: "Evolution of Modern Capitalism."
MALLOCK: "Classes and Masses."
COMMONS: "Selected Readings on Labor Problems."
WEBB: "Industrial Democracy."
British Royal Commission on Labor. Foreign Reports. (For historical account of social efforts at amelioration of wage-earners' condition in different countries.)
British Statutes (such as Friendly Societies Acts, Trade-Union Acts, and Workmen's Compensation and Trades Disputes Acts of 1906).
Monographs on Labor Legislation in several States. (Massachusetts, Pennsylvania.)
TOYNBEE: "Industrial Revolution."
ASHLEY: "Adjustment of Wages."
BOOTH: "In Darkest England and the Way Out."
CHAPMAN: "Work and Wages."
BRETANO: "The Relation of Labor to the Law of To-day."
DRAGE: "The Unemployed, and the Problem of Aged Poor."
GILMAN: "A Dividend to Labor."
SCHULZE, GAEVERNITZ: "Social Peace."
MITCHELL: "Organized Labor."
United States Bureau of Labor Bulletins, No. 18 (Sept., 1898), pp. 665-570; No. 30 (Sept., 1900), pp. 913–915; No. 53 (July, 1904), pp. 703–728.
ADAMS AND SUMNER: "Labor Problems," pp. 3–16, 502–547.
LEVASSEUR: "American Workman," pp. 436–509.
MITCHELL: "Organized Labor," pp. 391–411.
"Twelfth Census." Special Report on Employees and Wages, p. xcix.
"National Civic Federation, Industrial Conciliation," pp. 40–48, 141–154, 238–243, 254–266.
GLADDEN: "Working People and Their Employers."

"Workmen's Compensation," U. S. Dept. Commerce and Labor.
"Workmen's Insurance and Compensation Systems," U. S. Bureau of Labor.

Finance, Banking, and Currency.

Aldrich: "Money and Credit," Chapters, I, II, V.
Bryan: "Credit, Its Meaning and Moment."
Walker: "Money."
Zimmerman: "Credits and Collections."
Hepburn: "Contest for Sound Money."
Kinley: "Money."
Johnson: "Money and Currency."
Lewis: "The Credit Man and His Work."
Preston: "Credits, Collections, and Their Management."
Watson: "History of American Coinage."
Dewey: "Financial History of the United States," pp. 34–59, 76–117, 224–246, 252–262.
Catterall: "The Second Bank of the United States," pp. 1–24, 63–119, 376 map, 402–403, 464–477.
Bullock: "Essays on the Monetary History of the United States," pp. 60–93.
Hamilton: "Reports on Public Credit." Amer. State Papers, Finance, Vol. I, pp. 15–37, 64–76.
Kinley: "History of the Independent Treasury," pp. 16–39.
Summer: "Andrew Jackson" (ed. 1886), pp. 224–249, 257–276, 291–342.
Ross: "Sinking Funds," pp. 21–35.
Scott: "Repudiation of State Debts," pp. 33–196.
Bourne: "History of the Surplus Revenue of 1837," pp. 1–42, 125–135.
Conant: "History of Modern Banks of Issue," pp. 3103–47.
Mitchell: "History of the Greenbacks," pp. 3–43, 403–420.
Noyes: "Thirty Years of American Finance," pp. 1–72, 234–254 (73–233).
Taussig: "Silver Situation in the United States," pp. 1–157.
Dunbar: "National Banking System," Q. J. E., Vol. XII, pp. 1–26; printed also in Dunbar's "Economic Essays," pp. 227–247.
Howe: "Taxation and Taxes in the United States under the Internal Revenue System," pp. 136–262.
"Tenth United States Census" (1880), Vol. VII; Bayley, "History of the National Loans," pp. 369–392, 444–486.
White: "Money and Banking."
Taylor: "Chapters on Money."
Dunbar: "Theory and History of Banking."

Industrial History of the United States.

Coman: "Industrial History of the United States."
Taussig: "Tariff History."
Dewey: "Financial History."
Hart: "American History as told by Contemporaries," Vols. III and IV.
Semple: "American History and its Geographic Conditions."
Bullock: "Selected Readings in Economics."

CAIRNES: "The Slave Power."

CALLENDER: "Early Transportation and Banking Enterprises in relation to the Growth of Corporation," in Quarterly Journal of Economics, Vol. XVII.

NOYES: "Recent Economic History of the United States," in Quarterly Journal of Economics, Vol. XIX.

DAY: "History of Commerce."

HAMILTON: "Report on Manufacturers," in Taussig's State Papers and Speeches on the Tariff, pp. 1–79, 103–107 (79–103).

BOLLES: "Industrial History of the United States," Book II, pp. 403–426.

BISHOP: "History of American Manufacturers," Vol. II, pp. 256–505.

BABBENO: "American Commercial Policy," pp. 146–183.

RINGWALT: "Development of Transportation Systems in the United States," pp. 41–54, 64–166.

CHITTENDEN: "Steamboat Navigation on the Missouri River," Vol. II, pp. 417–424.

SEMPLE: "American History and its Geographic Conditions," pp. 52–74.

DONALDSON: "Public Domain," pp. 1–29, 196–239, 332–356.

SANBORN: "Congressional Grants of Land in Aid of Railways," Bulletin of University of Wisconsin Econ., Pol. Sci. and Hist. Series, Vol. II, No. 3, pp. 269–254.

HART: "History as Told by Contemporaries," Vol. III, pp. 459–478.

QUAINTANCE: "Influence of Farm Machinery," pp. 1–103.

BEMIS: "Discontent of the Farmer," J. Pol., Ec., Vol. I, pp. 193–213.

JOHNSON: "American Railway Transportation," pp. 24–68, 307–321, 367–385.

Organization of Business Enterprises.

BENTLEY: "Corporation Finance and Accounting."

SULLIVAN: "American Corporations."

VEBLEN: "The Theory of Business Enterprise."

WOOD: "Modern Business Corporations."

CONYNGTON: "Corporate Organization."

FRANK: "Science of Organization and Business Development."

KIRSCHBAUM: "Business Organization and Administration."

SPARLING: "Business Organization."

MEADE: "Corporation Finance."

DUNCAN: "Principles of Industrial Management."

HENDRICK: "The Power to Regulate Corporations and Commerce."

RIPLEY: "Trusts, Pools, and Corporations."

FLOY: "Valuation of Public Utility Properties."

BURTON: "Corporations and the State."

WHITTEN: "Valuation of Public Service Corporations."

GREEN: "Corporation Finance."

MEADE: "Trust Finances."

COMMON: "Trade Unions and Labor Problems."

WEBB: "Industrial Democracy."

HOBSON: "Evolution of Modern Capitalism."

ELY: "Monopolies and Trusts."

Industrial Commission Report.

Commissioner of Corporations: Report on the Beef Industry; Report on the Transportation of Petroleum; Report on the Petroleum Industry.

Montague: "The Ethics of Trust Competition, in Atlantic," Vol. XCV.

Montague: "The Transportation Phase of the Oil Industry," in Journal of Political Economy, Vol. XV.

Adams: "The Relation of the State to Industrial Action," in American Economic Association Publication, Vol. I.

Willoughby: "Integration of Industry in the United States," Vol. XVI, pp. 94–115.

Noyes: "Recent Economic History of the United States," Vol. XIX, pp. 188–209.

Twelfth Census, Vol. VII, pp. 110–214.

Industrial Commission, Vol. XIII, pp. 5–18.

Bullock: "Trust Literature," Vol. XV, pp. 167–217.

Transportation.

Cooley: "The Theory of Transportation."

Johnson: "American Railway Transportation."

Johnson: "Ocean and Inland Water Transportation."

Hadley: "Railroad Transportation."

Meyer: "Government Regulation of Railway Rates."

Ripley: "Railway Problems."

Newcomb: "Railway Economics."

Noyes: "American Railroad Rates."

Meyer: "Railway Legislation."

"Industrial Commission," Vol. XIX, pp. 466–481.

Adams: "Chapters of Erie," pp. 1–99, 333–429.

Davis: "The Union Pacific Railway, Annals of the Amer. Acad.," Vol. VIII, pp. 259–303.

Villard: "Memoirs," Vol. II, pp. 284–312.

Dixon: "Interstate Commerce Acts as Amended," Vol. XXI, pp. 22–51.

Chisholm: "Inland Waterways."

Selling and Advertising.

Atkinson: "Psychology of Salesmanship."

Bridgewater: "Advertising."

Balmer: "The Science of Advertising."

Bellamy: "Effective Magazine Advertising."

Bunting: "Specialty Advertising."

Bowker: "Copyright, Its History and Its Law."

Shryer: "Analytical Advertising."

Starch: "Principles of Advertising."

System Co., "How to Write Letters That Win."

Singer: "Patent and Trade Marks Laws of the World."

Swan: "Patents, Designs and Trade Marks."

Thompson: "Things to Know about Trade Marks."

Vardaman: "The Master Salesman."

Corbion: "Principles of Salesmanship."

Collins: "Human Nature in Selling Goods."
Casson: "Ads and Sales."
Calkins and Holden: "Modern Advertising."
Coleman: "Advertising Development."
Cherington: "Advertising as a Business Force."
Copyright Office Bulletins.
Davenport: "Value and Distribution."
DeWeese: "Principles of Practical Publicity."
Fowler: "Practical Salesmanship."
Farrington: "Store Management."
Hirschler: "Art of Retail Selling."
Hesseltine: "Law of Trade Marks and Unfair Trade."
Johnson: "Library of Advertising."
Knox: "Salesmanship and Business Efficiency."
Lenington: "Seven Principles of Successful Salesmanship."
Lindgren: "The New Salesmanship."
Lawrence: "Making Him Buy."
Macbain: "Selling."
Moody: "Men Who Sell Things" Moran, "The Business of Advertising."
MacDonald: "Successful Advertising."
Parson: "Principles of Advertising Arrangement."
Page: "Advertising."
Newell: "Patents, Copyrights and Trade Marks."
Pierce: "Scientific Salesmanship."
Powell: "Practical Advertiser."

Statistics.

Davenport: "Statistical Methods."
Mulhall: "The Dictionary of Statistics."
Bowley: "Elements of Statistics."
Meitzen: "History, Theory, and Technique of Statistics."
Newsholme: "Vital Statistics."
Bertillon: "Cours Elementair."
Levasseur: "La population francaise."
Block: "Traité de statistique."
Mayo-Smith: "Statistics and Economics."
Dewey: "Discussion of Wage Statistics in volume on Wages, 12th U. S. Census."
Consular Reports (British and American).
Publications of Census Bureau (and of other Departments on Labor, Trade, and Finance).
British Board of Trade Publications.
Journal of the Royal Statistical Society.
Journal of the American Statistical Society (Articles by Mitchell, James, Bullock, etc.).
Publications of the State Labor and Statistical Bureaus.

Trade Unions.

Kirk: "National Labor Federations in the United States."
Webb: "Industrial Democracy."

Commons: "Trade Unions and Labor Problems."
Hollander and Barnett: "Studies in Trade Unionism."
Cogley: "The Law of Strikes, Lockouts, and Labor Organizations."
Eddy: "The Law of Combinations."
Ely: "The Labor Movement in America."
Howell: "Trade Unionisin, New and Old."
Mitchell: "Organized Labor."
Peters: "Labor and Capital."
Spedden: "The Trade Union Label."
U. S. Industrial Commission Reports.
Webb: "History of Trade Unionism."

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